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HOMEWARD BOUND—U. S. S. RALEIGH ON HER VOYAGE FROM MANILA TO NEW YORK.

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HOMECOMING OF THE U. S. S. RALEIGH OF ADMIRAL DEWEY'S FLEET.

Among the U. S. vessels which participated in the sea fight at Manila, May, 1898, was the U. S. S. *Raleigh*. She also had the distinction of previously firing the first shot during the night entrance of the fleet into the bay. After the victory in Manila Bay the *Raleigh* rendered distinguished services in the subsequent operations under Admiral Dewey. Late last year she was ordered home, and she arrived in New York harbor April 16 to be greeted by the Mayor of the city officially and the citizens of New York in thousands unofficially.

The arrival of the war vessel on Sunday, in weather about as disagreeable as could be manufactured, diminished the size but not the earnestness of her welcome home after an absence of two years. It was not alone in honor of the *Raleigh*, however, that the tugs whistled, steamships saluted and the people cheered, but also because she was a representative of the fleet of Admiral Dewey, whose homecoming will undoubtedly be the occasion of one of the most patriotic demonstrations in the history of the country. At Quarantine the cruiser was met by the Spanish prize gunboats, *Sandoval* and *Alvarado*, and escorted by a fleet of screeching tugs she went up the North river as far as Grant's tomb and fired a national salute. Afterward the *Raleigh* anchored in the North river and visitors from shore were entertained while she remained in New York.

After her run of 12,584 miles the *Raleigh* looked as trim and serviceable as she did on the eventful first of May. Her log shows that she left Manila Dec. 15, 1898, and, in succession, touched at Singapore Dec. 21 to 31, Colombo Jan. 7, 1899, to Jan 13, Bombay Jan. 18 to Jan 19, Aden Jan. 27 to Feb. 1, Port Said Feb. 8 to Feb. 12, Alexandria Feb. 13 to Feb. 22, Malta Feb. 26 to March 6, Algiers March 16 (left), Gibraltar March 18, Punta Delgado March 23 to March 27, Horta April 1 (left), Bermuda April 9 to April 13, arriving at New York April 16.

Our artist has depicted the *Raleigh* "homeward bound" crossing the Atlantic on her westward voyage. This fine ship was built at the Norfolk Navy Yard, where she was launched in March, 1892, going into commission in April, 1894. Her dimensions are: Length, 300 ft.; beam, 42 ft.; depth, 18 ft., and displacement, 3,213 tons. She is a twin screw vessel, fitted with triple expansion engines of nearly 10,000 I. H. P., and on her trial she attained a speed of 19 1-2 knots. She is armed with ten 5 in. rapid-fire and one 6 in. slow-fire guns; also eight 6-pounders and four 1-pounder rapid firers, and machine and field guns. She is also provided with two Whitehead torpedo tubes. She is classed as an unarmored steel protected cruiser, having a protective deck ranging in thickness from 2 1-2 in. down to 1 in.

A significant incident of the voyage occurred while the *Raleigh* was steaming out of Gibraltar. She met Admiral Camara's fleet coming in, and Captain Coghlan politely raised the Spanish ensign and fired a salute, which was quickly responded to by the Spanish flagship.

THE ARTHUR SEWALL, AN AMERICAN SHIPENTINE BUILT OF AMERICAN STEEL.

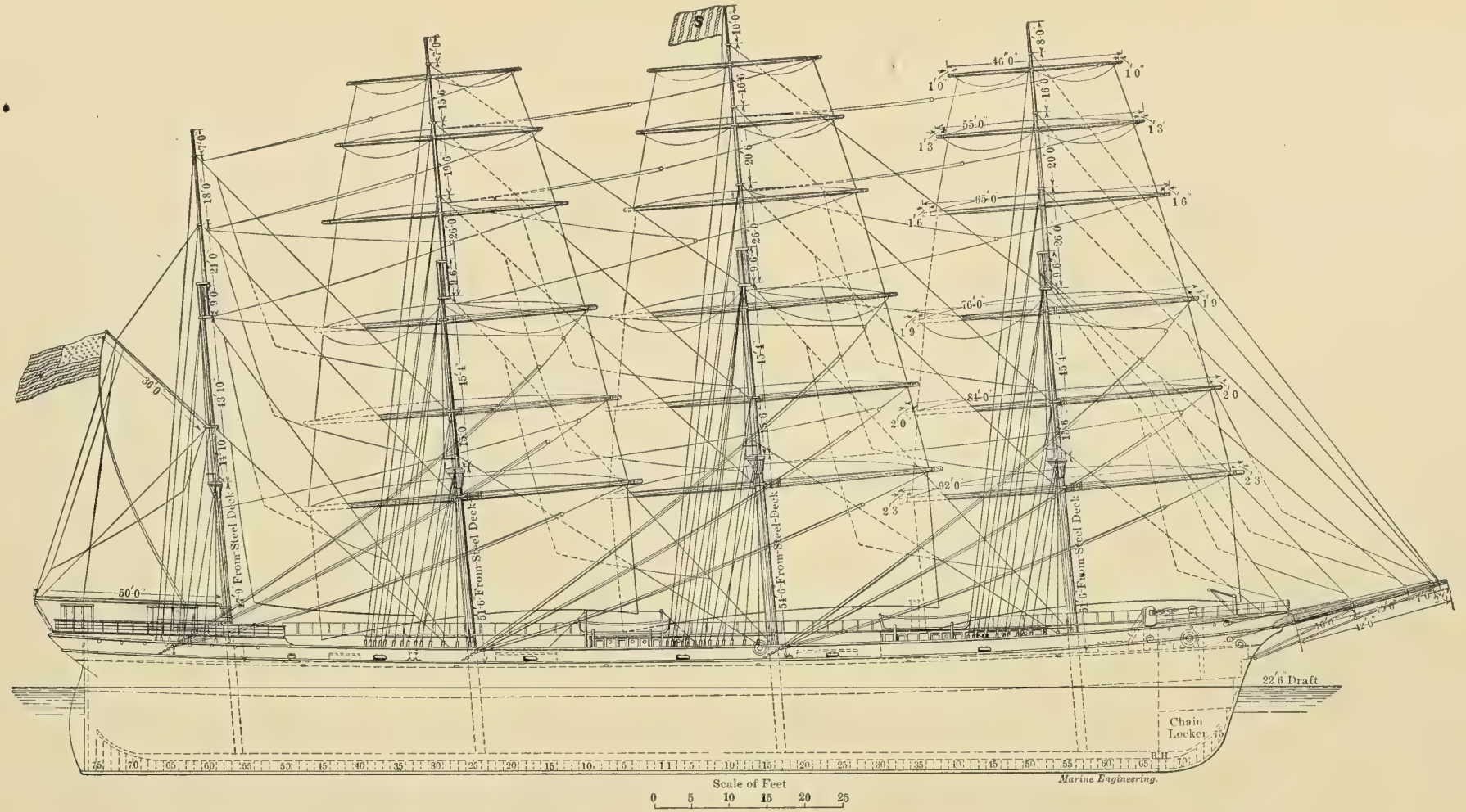
This fine vessel is the largest steel sailing ship ever built in the United States, and is the third steel vessel built by Arthur Sewall & Co., shipbuilders and ship owners of Bath, Me. She was launched Thursday, February 23, and is at the present time engaged in loading for a voyage. The *Arthur Sewall* is a strong, rigid steel vessel, and her scantlings are equal to or in excess of the requirements of all the first-class classification societies. It was originally intended that she should receive the highest rating in the British Lloyds, but the owners finally decided to class her in both the Bureau Veritas and the American Bureau of Shipping.

The principal dimensions of this new vessel are:

Length over all	about 354 ft.
" L. W. L.	332 "
Beam moulded	45 "
Depth, side	27 " 3 in.
" center	28 " 3 "
" of hold	25 " 8 "
Designed load draught	22 " 6 "
Registered length	332 "
" beam	45 "
" depth	25.6 ft.
" gross tonnage	3,209.3 tons.
" net "	2,919 "

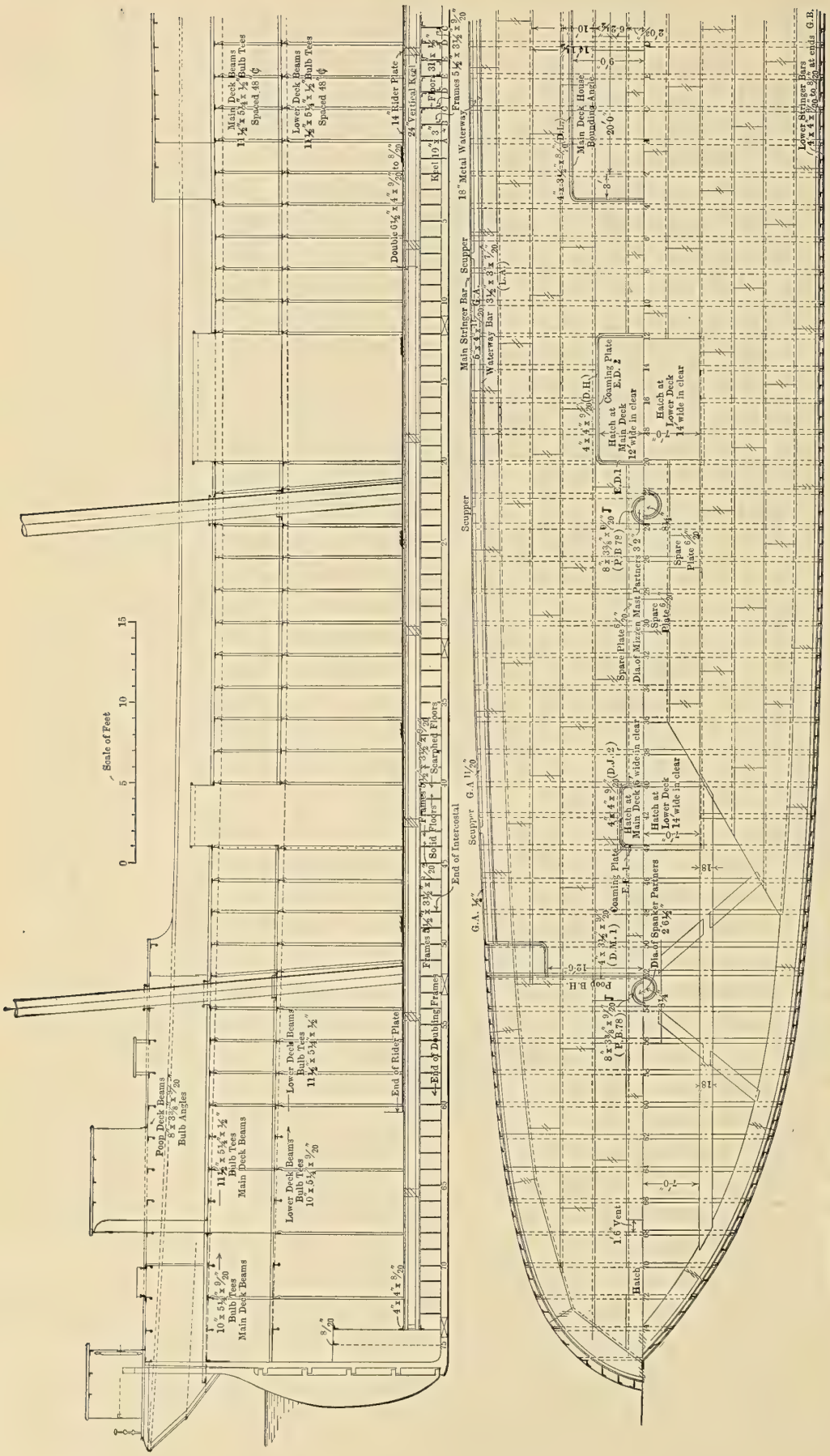
The *Arthur Sewall* has a dead rise of 20 in. and an easy turning bilge. She has the usual tumble home amidship; and a deck camber of 12 in. in 45 ft. The frames are 5 1-2 in. by 3 1-2 in. by 9-20 in. angle bars spaced 24 in. apart, with a reverse frame 4 in. by 3 in. by 9-20 in. angle bar on every frame running alternately to the main deck and lower deck stringers. The floor plates are 2 ft. 7 in. deep in the center and 10-20 in. thick; they are furnaced and carried in one piece from a point near the center line, to the upper turn of the bilge. The vessel has a bar keel, and her keel, stem and stern post are the same size, viz., 10 in. by 3 in. The vertical keel is placed on top of the floors and consists of a plate 24 in. by 15-20 in. placed vertically with two angle bars on the top and two on the bottom, each 6 1-2 in. by 4 in. by 9-20 in.; a rider plate is fitted on the top 14 in. wide and 14-20 in. thick. There are two side keelsons on each side of the vertical keel, and on the side of the vessel midway between the floors and the lower deck beams, an orlop stringer plate is worked 45 in. wide by 9-20 in. thick. This plate is stiffened on the inside by longitudinal angle bars and is well bracketed to every alternate frame.

The *Arthur Sewall* is a two decked vessel, and both the lower and main decks are continuous and extend throughout the vessel's length. The main deck beams are of bulb T sections, 11 1-2 in. deep and 10-20 in. thick, spaced 48 in. apart. This deck is plated throughout and sheathed with yellow pine 5 in. by 3 1-2 in. The lower deck is 8 ft. 3 in. below the main deck and runs parallel to it. The beams of this deck are the same size and have the same spacing as the main deck beams. It is plated with steel for about 200 ft. amidship and a wood deck of yellow pine 6 in. by 3 in. is laid throughout. The bulwarks of this vessel are 5 ft. high amidship, but this dimension is increased fore



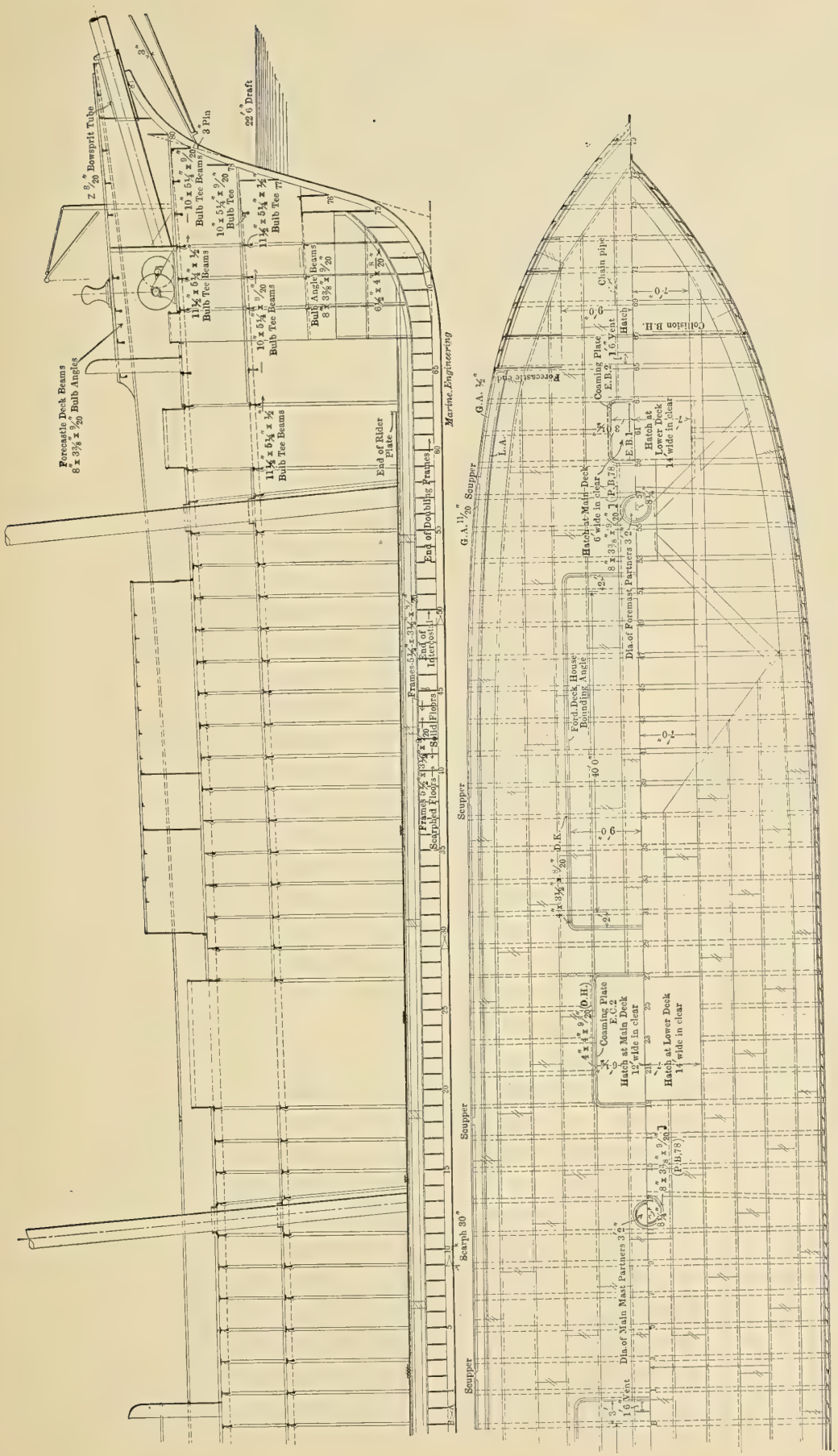
SAIL PLAN OF THE NEW AMERICAN STEEL SHIPENTINE ARTHUR SEWALL, 2,860 TONS. BUILT BY ARTHUR SEWALL & CO., BATH, ME.

and aft and the apparent sheer of the bulwarks is not parallel to the line of the main deck. By this arrangement a forecastle forward and poop aft with full head-room are obtained without any conspicuously high houses on the ends. The forecastle and poop decks are worked parallel to the line of the main deck and a turtle back varying in depth connects these decks to the steel bulwarks. The building tonnage of the *Arthur Sewall* is 2,860 tons and the Lloyds numerals for the vessel are: 1-2 girth 46 ft., depth 28.25 ft., 1-2 beam 22.5 ft., length 328.3 ft. First numeral or transverse number = 96.75, second numeral or longitudinal number = 31,763, ratio length to depth 11.62, ratio length to beam 7,295. The vessel has two roomy steel deck houses. The forward house, which is 46 ft. long and 18 ft. wide, contains the crew's quarters. This room contains 20 berths, and it is well lighted and venti-


Scale of Feet
0
5
10
15
Poop Deck Beams
8 x 3½ x 9/20
Bulb Angles
Main Deck Beams
11½ x 5¼ x 9/20
Bulb Tees
Lower Deck Beams
10 x 5¼ x 9/20
Bulb Tees
4" x 4" x 9/20
9/20
End of Rider Plate
End of Doubling Frames
Frames 9½ x 3½ x 9/20
Solid Floors
Scarphed Floors
End of Intercostal
Scupper
G.A. 14"
G.A 11/20
Poop D.H.
Hatch
16' Vent
Dia. of Spanker Partners 26½"
Coaming Plate E.F.1
4" x 14" x 9/20 (D.M.1)
8 x 3½ x 9/20 (P.B.78)
Hatch at Main Deck 6' wide in clear
Hatch at Lower Deck 14' wide in clear
Spare Plate 6/20
Dia. of Mizzen Mast Partners 32"
8 x 3½ x 9/20 (P.B.78)
Coaming Plate E.D.1
Hatch at Coaming Plate Main Deck 12' wide in clear
4" x 4" x 9/20 (D.H.)
Hatch at Lower Deck 14' wide in clear
Spare Plate 6/20
4" x 4" x 9/20 (D.J.2)
Main Deck House Bounding Angle
4 x 3½ x 9/20 (D.L.)
Main Stringer Bar
5 x 4 x 17/20
Waterway Bar 9½ x 3½ x 9/20 (L.A.)
18" Metal Waterway
Frames 5½ x 3½ x 9/20
Floors 10 x 3
Keel 10 x 3
Double 6½ x 4 x 9/20 to 9/20
14" Rider Plate
24" Vertical Keel
Main Deck Beams
11½ x 5¼ x ½ Bulb Tees
Spaced 48 c/c
Lower Deck Beams
11½ x 5¼ x ½ Bulb Tees
Spaced 48 c/c
Lower Stringer Bars
4 x 4 x 9/20 to 3/8 at ends
G.B.

WORKING DRAWINGS OF THE NEW STEEL SHIPENTINE ARTHUR SEWALL. BUILT BY ARTHUR SEWALL & CO., BATH, ME.—AFTER END.

lated with both air ports and skylights. The remainder of the forward house is devoted to the galley, donkey boiler, engine room and coal bunker. The amidship deck house is 26 ft. long and 18 ft. wide. It contains the carpenter's shop, and six rooms for the petty officers. Aft in the poop is a well arranged, commodious cabin, finished in white and artistically decorated for Captain James F. Murphy, who will be the ship's commander, and the Commodore of the Sewall fleet of sailing ships. This cabin, which is 48 ft. long and 38 ft. wide, is well lighted and ventilated by means of skylights. In the forward part is the dining room and adjoining is the main saloon. A hallway is situated on the port side, opening from which are the officers'



WORKING DRAWINGS OF THE NEW STEEL SHIPENTINE ARTHUR SEWALL. BUILT BY ARTHUR SEWALL & CO., BATH, ME.—FORWARD END.

staterooms. Captain Murphy's apartments are on the starboard side. The cabin is supplied with a large steward's pantry, store rooms, lavatories and bath rooms. A spiral stairway leads from the cabin to the chart house on the poop deck. This house is 14 ft. by 16 ft., and part of it will be used for the accommodation of two passengers. The vessel is steered by screw steering gear, the helmsman being protected by a steel hood open at the forward end. A large fore and aft flying bridge is fitted, connecting the poop, deck house and top gallant forecastle. This bridge is portable in wake of the hatches and in bad weather it will undoubtedly prove a great convenience.

The *Arthur Sewall* will carry 5,000 tons dead-

weight on a draught of 22 ft. 6 in., and she will stand up without ballast when light in port. The vessel has great stability at light draught, and she will prove a good, seaworthy, stable ship when loaded with any homogeneous cargo. Her proportions of length to depth and length to beam are rather excessive, for she is approximately an *Erskine M. Phelps*, with a parallel middle body of 20 ft. inserted amidship. She is not by any means a full ship, her block co-efficient at the designed load draught excluding the keel being only about .73. The *Arthur Sewall*, like her predecessors, has a neat, well proportioned sail plan. The lower masts and topmasts are of steel in one length, and the top gallant and royal masts are of wood in one piece. The spike bowsprit and three lower yards on each mast are made of steel, while all the remaining smaller spars are of wood. The fore, main, mizzen and jigger lower masts, including the topmasts, are 107 ft., 110 ft., 107 ft., and 100 ft., respectively, above the main deck. The fore top gallant and royal masts are 70 ft. long, the main 72 ft., the mizzen 61 ft. and the jigger 49 ft. long. The lower yards are each 92 ft. long; the topsail yards measure 84 ft., the upper topsail yards 76 ft., the top gallant yards 65 ft., the royal 55 ft. and the skysail 46 ft. She has six yards on each of the fore, main and mizzen masts, and being rigged as a shipentine, she carries no yards on the jigger mast. The spike bowsprit projects 45 ft. beyond the bow; the spanker boom is 50 ft. long and the gaff about 36 ft. She has four head sails, three main, three mizzen and four jigger stay sails, which makes a total of thirty-four sails all told. The standing rigging is of wire rope set up with turnbuckles. The fore, main and mizzen masts have each five shrouds and two backstays, two topmast backstays, two topgallant, and two royal backstays. The jigger mast is fitted with four shrouds and one backstay, two topmast backstays, one top gallant and one royal backstay.

The *Arthur Sewall* is fitted with all modern appliances for the rapid handling and stowing of cargo. A donkey engine of 25 H.P. works the ship's windlass by means of a messenger chain, and the same motive power is used in port for discharging and taking on cargo. The vessel is equipped with three bower anchors, two of which weigh 5,000 lb. each, while the third weighs 4,250 lb., excluding stock. She has also one 1,700-lb. stream anchor, and two kedges of 850 lb. and 560 lb. weight respectively. Her main cable consists of 300 fathoms of 2 5-16 in. stud link chain, and she is also fitted with 120 fathoms of 1 3-16 in. stream chain and 90 fathoms of flexible steel wire tow line, besides the usual hawsers and warps. The windlass is of the steam capstan "Hyde" type, and two hand capstans have also been fitted. The running lights are carried in steel light-houses forward. There are two large portable cranes on the forecastle deck for the handling of the anchors. The total complement of the *Arthur Sewall* will consist of the Captain, four Mates, Engineer, Sail Maker, Cook, Steward, twenty seamen and eight boys, or thirty-seven men all told.

The cost of the *Arthur Sewall* cannot at this time be accurately ascertained, but it will probably be about $155,000, or a little over $48 per ton. It is indeed gratifying to know that Arthur Sewall & Co., without reducing the wages of their shipyard mechanics, have been able to construct two steel sailing ships, the *Erskine M. Phelps* and the *Arthur Sewall*, at their own yard, at a price about equal to that paid by British builders for the same class of tonnage. They have had to pay more than British builders for labor, but they have saved by duplication and the lower cost of American steel. This latter fact is particularly significant and worthy of note, for when the *Dirigo* was constructed, only five years ago, the builders bought all their steel from Motherwell, near Glasgow, Scotland, and at that time the British steel, plus the price of transportation, could be obtained cheaper than steel of domestic manufacture. Arthur Sewall & Co. are now about to lay the keel of another shipentine, which will be very similar to the *Arthur Sewall*. The accompanying plans show the design and dimensions of this fine vessel very clearly.

The *Arthur Sewall* is in reality a duplicate of the *Erskine M. Phelps*, with an additional parallel middle body of 20 ft., inserted amidships, and the scantling and stiffening increased on account of the additional length. William A. Fairburn, of Bath, Me., drew the plans for these vessels and acted as consulting naval architect for the builders and owners, Arthur Sewall & Co.

THE STEAM YACHT AS A NAVAL AUXILIARY IN THE LIGHT OF SPANISH WAR EXPERIENCES.*

BY W. P. STEPHENS.

The subject of this paper is but one of many that have already come before the Society in their theoretic aspects, and now, when tried by practice, it presents results which seem to be both definite and conclusive; and from which some useful lessons may be drawn.

The work of reconstruction which has been under way in the United States Navy for the past fifteen years has been limited almost entirely to the strictly fighting arm of the service—the battleships, cruisers and torpedo craft. Indispensable as they are, these of themselves do not constitute a perfect navy; in fact they are of comparatively little use without a large attendant fleet of auxiliary craft; transports, colliers, water boats, repair ships, supply ships, hospital ships, and small craft for various uses.

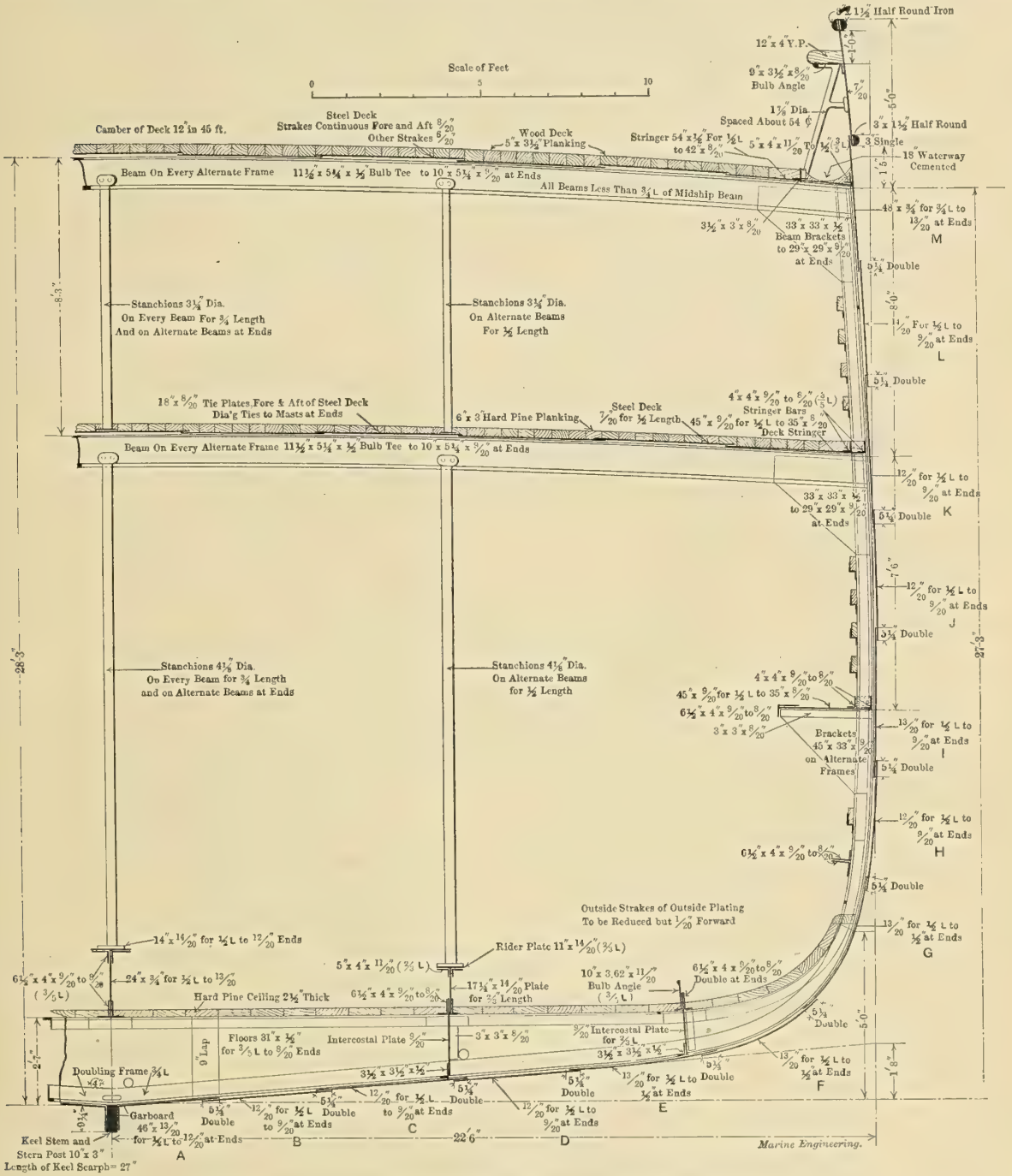
The condition of the Navy at the outbreak of hostilities between the United States and Spain may be briefly summed up as strong in its personnel; comparatively strong in fighting vessels, guns, and armor; and absolutely unprovided with auxiliaries of all kinds. Of all the urgent work demanded both ashore and afloat, nothing was more immediate and pressing than the creation of an efficient fleet of auxiliaries.

Among the numerous classes coming under this general head is one that is hardly accorded the distinction of a specific title in naval programmes, but which, in the present case, was needed for three im-

* Read at the Sixth General Meeting of the Society of Naval Architects and Marine Engineers, in New York.

portant uses, as follows: First. For sea service as tenders to the blockading fleet, and general service in the shoal harbors and rivers of the West Indies, where the war vessels were barred by their draught. Second. For picket duty off shore, constituting the "Second Line of Defense." Third. For harbor patrol

when the possibility of war had almost crystallized into a certainty. This Board proceeded at once to examine a very large number of vessels, ranging from the large passenger steamers of the American Line down to the smaller sizes of tugboats and yachts; and, in accordance with its reports, vessels



HALF CROSS SECTION OF THE STEEL SHIPENTINE ARTHUR SEWALL.

duty in connection with the guarding of mine fields and the enforcing of the war regulations governing ports and harbors.

The preparation of this particular branch was but one detail of the important task entrusted to the "Naval Auxiliary Board," specially created at a time

were purchased from the special appropriation made by Congress for the purpose of defense.

For the work above outlined two classes of vessels were selected, the ocean-going tug and the steam yacht, the latter to the number of twenty-seven. The selection was made from many localities, several

of the yachts coming from the Great Lakes. The vessels were mainly purchased direct from the owners, the price being fixed by the Board. As soon as the transfer of title was completed the yacht was delivered at the nearest navy yard, where the work was pushed as rapidly as possible. As a matter of course, the majority of the yachts hailed from New York, and the work on them was consequently executed at the Brooklyn Navy Yard.

The capabilities of this material for an emergency fleet for successful conversion to war purposes were, as we shall see later, not of the best; but the facilities for carrying out the work were in the main satisfactory, the skilled labor and the necessary material being readily obtained. The only difficulty encountered in this part of the work was in the detail of armament, there being a lack of some of the sizes of guns best fitted for these small vessels.

To the yachtsman at least, the sight of the well-known vessels as they left the Navy Yard was a surprise and also a shock; under a dull monochrome of "war paint" (lead color) covering everything from water line to truck, the distinctive color scheme of the yacht was effaced entirely; there was no longer a trace of the green "boot top," the jet black topsides relieved by gilded cove and trail boards and figurehead, with the sheer cut out cleanly by a strip of polished teak. The rich brown of the deck houses, the bright yellow of the spars, and the white sails set off by the parti-colored burgee at each truck, had all disappeared. The bowsprit was sawed off just outside the gammon iron and brought to a blunt point, the fore topmast shared a similar fate, projecting but a few feet above the cap, and the mainmast had disappeared entirely. A pair of 3 or 6 pounders grinned menacingly from the forecastle, a couple more from the quarterdeck, and bridge and deck house each showed an automatic gun. The rowing boats were retained, but the steam and naphtha launches were left ashore.

As each vessel was completed she was despatched to her station, many going direct to Key West, and from there to the Cuban coast; others were stationed along the coast of the eastern and Atlantic states to give warning of the approach of the expected Spanish fleet, while the smaller ones were assigned to duty in the harbors of New York, Boston, and other important seaports. At the outset the Sea Picket division was regarded as the most important of the three, but as matters turned out it had nothing to do, and after Cervera's fleet took refuge in Santiago Harbor, it was withdrawn and the vessels despatched to more southern stations. The work of the Harbor Patrol fleet was also very light, mere policing of the mine fields against the intrusion of garbage scows and coasting schooners.

While specific information as to the individual performances of the main division of the yacht fleet in actual service is not yet at hand, enough is known to establish the fact that the fleet, as a whole, acquitted itself creditably and fully justified its creation. While some of the converted yachts proved failures and entirely unfit for sea work, and others were only partly satisfactory, many of them have done excellent work under trying conditions. The part played by the Gloucester and the Vixen at Santiago was such as to bring them into special prominence, but the Mayflower, Yankton, Scorpion, and others have done regular and consistent service, though under conditions which have attracted less attention to them.

The work of laying up this fleet really began before the actual cessation of hostilities, the smaller yachts of the Harbor Patrol being withdrawn and placed out of commission at the Brooklyn Navy Yard and other points. One yacht, the Free Lance, presented to the Government by her owner, F. Augustus Schermerhorn, without conditions, was returned to him as soon as the need for her services in the New York Harbor Patrol fleet was over. Another similar gift, the Buccaneer, presented by W. R. Hearst, was also returned later on, being in Cuban waters when hostilities ceased. At the time of writing, most of the yachts have returned from the West Indies, the majority of these to go out of commission. The Gloucester, Scorpion, Vixen, Mayflower, and others of the larger and abler, are still in service. One yacht, a new craft uncompleted at the time of purchase and placed in commission only after the need for her was past, has been reserved for the special use of the President, a service heretofore performed by such Government tugs, lighthouse tenders, or other small craft as were temporarily available. She has been named the Sylph, and her original arrangements, as a private yacht, have been modified to suit this new use. No decision has yet been made as to the disposal of the yachts remaining, twenty-five in all, but it is probable that most of them will be offered for sale, ultimately returning to the pleasure fleet.

In summing up what has been at best an experiment arising from an emergency which should never have occurred, it may be said in regard to the home divisions of the converted fleet, the sea pickets and harbor patrol, that the course of the war has been such that no serious or prolonged service was required of either, and the merits of the fleet were not put to a practical test. Had, however, the anticipated attack upon the North Atlantic coast proved a reality, it is safe to say that the yachts would have met all expectations. In the case of the third division of the fleet, the vessels were put to the severe test of prolonged service at sea, under conditions for which they were never intended, and they were also engaged in attacks upon land fortifications and in some cases in engagements on the sea. The result of this test has been, on the whole, quite as satisfactory as could have been expected.

The possibilities of the yacht fleet at the present time for conversion to war uses were, even from a theoretic standpoint, far from promising. Many of the vessels were ill-fitted in model for real service at sea; there was a lack of displacement for the added weights of armament and ammunition, of berthing space for crew, of bunker space, and suitable locations for magazines. The nominal speed, in many cases low in itself, was not realized even in smooth water, and in a sea there was a serious loss of the average working speed. There was no protection, no distilling apparatus; the capacity of the water tanks was generally inadequate, and the decks were

not designed to withstand the shock of the guns. The draught as a rule was greater than was necessary or desirable. The nature and extent of these defects were fully realized at the outset, but under the circumstances there was no other course but to take the yachts as they were and to make the best of them. All things considered, they have done their work quite as well as was to be expected; they have served a certain necessary purpose, and they were capable of doing even more had it been required of them.

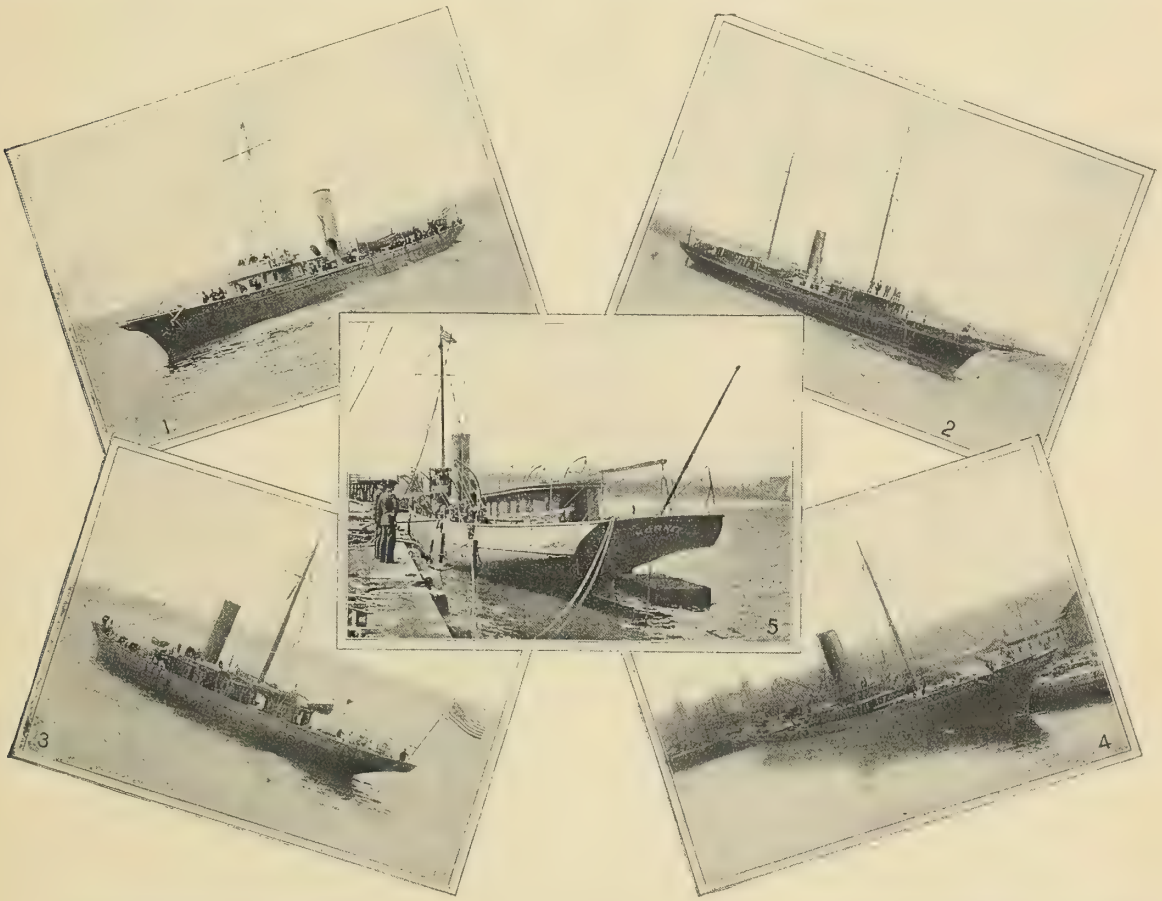
It is impossible within the limits of the present paper to discuss the auxiliary fleet as a whole; but to those of us who have followed the discussions of this society year by year the experiment must be an interesting one. The lessons to be derived from it are, first, the necessity for timely preparation in the speedy building up of an adequate navy; and, second, that to be done properly, this work must proceed for a term of years according to a comprehensive and systematic programme, completed in advance and carried out as nearly as possible without change through successive administrations.

The detail of the auxiliary fleet now under consideration, the yacht division, has, as I shall endeavor to show, a special lesson of its own; that the naval programme may be advantageously extended to include a type of small auxiliary indicated by the yacht, but not now in existence in this country.

The present use of the yacht fleet being confessedly but an emergency measure, the question naturally suggests itself as to whether such a course would have been necessary had our Navy been theoretically complete in all its branches; notably, had the gunboat and torpedo arms, instead of being exceedingly weak, been developed to the same extent as in other navies?

This question may at once be answered in the affirmative, for the reason that none of the vessels of the gunboat or torpedo boat types are adapted for the special service demanded of the converted yachts. The high speed which is the leading motive of torpedo boat design is not only needless for the work now under discussion, but entails the loss of many essential qualities. Incidentally, it may be observed, there has been, with the exception of one yacht, Mayflower, no attempt to convert the yachts into torpedo boats; and had there been enough torpedo boats at hand for this service, the only available crews, largely made up from the Naval Militia, would have been unfit to handle them.

Assuming, then, that however perfect the torpedo arm may be, there is still a distinct field of usefulness for something of the yacht type, we come to the



1. U. S. S. Hist, formerly S. Y. Thespia. *2. U. S. S. Stranger, formerly S. Y. Stranger.*
5. U. S. S. Hornet, formerly S. Y. Alicia.
3. U. S. S. Gloucester, formerly S. Y. Corsair. *4. U. S. S. Scorpion, formerly S. Y. Sovereign.*

question discussed at the first meeting of this Society in 1893, of the policy of reliance upon the pleasure fleet as a regular means of defense in the future.

The suggestion has been made in this connection that some scheme of co-operation between the Government and individual yacht owners might be put into practice whereby, in return for certain privileges or compensations on the part of the former, the latter might be induced to plan any new yachts with a direct view to their conversion to war uses. The objection both to this method of procedure and to the general policy of reliance on the yacht fleet are very strong. On the part of the Government, the only effective inducement to be offered to the owner must be in some form of subsidy, a sort of special legislation which is practically impossible. On the part of the owner, his personal requirements, to say nothing of the wishes of his captain, his wife, and his friends, are directly opposed to those of the war vessel. There is, it is true, a common ground whereon the owner and the Government might come together to mutual advantage in demanding the essentials of good design, a seagoing model, fair working speed, ample bunker space, etc., but in too many cases these are but secondary to the demand for spacious saloons and lavish display of furnishings. To the owner who is willingly paying a very large sum for mere luxury and elegant appointments, the Government can offer but slender inducements to make his vessel a ship first and a palace afterward; or, when completed, to loan her for a time as a practice ship, as has been suggested as one feature of the scheme.

Unless very much more can be done in this direction than now seems possible, the experience of the present year is such as to indicate that the purchase and conversion of yachts is in every way undesirable as a permanent feature of naval policy. The defects of the existing fleet have been already indicated; many of them are mere matters of faulty design due to the haphazard methods that have thus far largely prevailed in this country, the owner leaving everything to his captain, who in turn deals directly with a builder. This class of defects will largely disappear as soon as the American yacht owner awakens to the appreciation of the importance of the trained specialist, the yacht designer, in the field of steam yachting as he has long since done in that of the sailing yacht. At the same time the good qualities of a perfect steam yacht are not of necessity such as to make her an ideal picket or patrol boat; and of the fleet available at any future time for conversion, many will be found to possess positive bad qualities, as in the present case.

As a matter of permanent policy, however, the question of the efficiency of the converted yacht is but secondary to that of the cost, always a controlling one in a naval programme. The circumstances attending the purchase of yachts for this purpose are necessarily such as to keep the price at a fair figure, and this price represents a large amount of furniture and decoration which is worse than useless, as its very removal entails some expense. Apart from this waste, the yacht needs to be strengthened for gun mounts, etc., and remodeled in all the internal details. When the emergency is passed and she is no longer needed, her value as a yacht will have seriously depreciated, and the work of reconversion must be far more costly than that of the first change, as its details are reversed. Where the furnishings were hastily stripped at a mere cost of labor, new ones must be purchased and put in place; where spars were simply sawed off, new ones must be made and shipped; and in place of a plain coat of lead color over everything, regardless of appearance, the entire structure must be scraped and redecorated by skilled artisans. When the present experiment has reached its final stage in the sale of many of the yachts, and the result is reduced to plain dollars and cents, there will probably be little room for doubt as to the unprofitable nature of the work.

While the actual co-operation of the Government and the yacht owner is hardly practicable, each may study with profit the lesson now before them. It is obviously to the interest of the Government to encourage the building and use of yachts; apart from the indirect advantages of a national pleasure fleet, there is always the possibility of an occasion like the present, when the larger vessels must be depended on as a *dernier ressort.* While nothing can be done in the way of direct financial aid, it is a wise and sound policy to encourage yachting by the removal of all unnecessary and oppressive regulations.

On the part of the owner, it must be apparent to him now, if never before, that his interest lies directly in putting his money into a vessel that as far as possible possesses the prime essentials for conversion to war use. It may happen, as in this case, that the opportunity to sell her at a fair figure is coincident with a temporary inability to use her on account of war. How far he can go in the compromise between his individual requirements and adaptability for conversion is a question to be settled with his designer; but he will hardly fail to realize that it is too important a matter to be disregarded entirely, as it has been in the past.

A careful study of the history of the yachts in the present war will show two important points: first, the theoretic value of vessels of the yacht type; and second, the limited extent to which the yacht fleet as a whole has realized in practice its theoretic efficiency. The work demanded and in part accomplished by the yachts is not properly within the field of either the gunboat, the destroyer, or the torpedo boat. The former is too large; the torpedo vessels, of all classes, are designed mainly for a speed which not only is absolutely unnecessary for this special work, but is obtained through the sacrifice of essentials.

The gunboat class in the new Navy had its origin in the Petrel, built in 1887, of 850 tons displacement, 11 ft. 7 in. mean draught, and 11.5 knots speed; a vessel now notable from her part in the battle of Manila Bay. The development of this class since then has been entirely upward, to vessels of 1,700 tons displacement; and no attempt has been made to carry it downward from the Petrel. Useful as they are, the gunboats now in service and the new ones under construction are unfitted by their size for the work assigned to the yachts.

So far as the torpedo boat is concerned, the pres-

ent war has been devoid of results; not only is the question of the true relative value of the torpedo fleet as much an open one as it was a year ago, but false lights have been thrown on it (through the poor performance of the Spanish destroyers, and also the good work of the converted yacht Gloucester) which are calculated to mislead, at least the popular mind. It cannot be too strongly stated that the idea, quite widely prevalent, that one converted yacht is the equal of two of the modern torpedo boat destroyers, is entirely erroneous. The destroyer and torpedo boat are to-day quite as formidable as they were a year ago, quite as essential, and with a wide field of usefulness on which nothing of the yacht type can intrude. At the same time, their limitations are numerous and well defined; they are necessarily most expensive and delicate machines, lacking protection, armament, bunker space, and crew accommodation; they demand special picked crews, whose endurance is severely tested in comparatively short trips at sea; and they are at all times liable to speedy deterioration. The value of each individual boat depends mainly on the spirit and training of her crew and her excess of speed above others of her class. Had there been at hand this spring an ample fleet of torpedo boats, they would have been of but little use for the reasons that the trained crews to man them were lacking, and the men who were available, largely from the Naval Militia, were incapable of handling such delicate tools.

The work of the yachts, their success and failures taken together, with the work of other small craft such as tugs, lighthouse tenders, etc., impressed into the same service, seems to indicate the desirability of the creation of a new type of small auxiliary not at present recognized on the Navy list. The controlling feature of design—the speed—may at the outset be placed at a moderate figure for this era of increasing speeds, not over 18 knots. This, however, is not to be measured by the conventional yacht standard by which an 18 knot steam yacht takes the wash of a good 12 knot tug, but means a reasonable approach to the designed speed under ordinary service conditions at sea, and the ability to keep with the fleet even in bad weather. The model should possess seagoing qualities of the highest class; the draught should be limited to 11 or even 10 ft. as a maximum; the construction should be durable, with ample scantling both to carry the armament and to insure a long life with care in lying up; the engines should be strong and reliable, the bunker space as large as possible, and, as deck and side protection will probably be impracticable, especial attention should be given to the waterline protection of machinery and magazines through their location and the disposition of the bunkers. The accommodation should include healthy and comfortable quarters for a proportionately large complement of officers and crew for an indefinite time, and the armament should be comparatively powerful, with the guns more advantageously located than is possible on a yacht. Special provision should be made for magazines, ammunition hoists, distilling apparatus, and minor auxiliaries. There should be no sails, and no spars except the single military mast, and in all cases torpedo tubes should be excluded. Profiting by one serious defect of the yachts, special attention should be directed to the disposition of space in holds and bunkers so that it may be utilized to advantage without a material change of trim.

The intended uses of this class call for three sizes: for sea work, as despatch boats and tenders, and for picket duty, vessels of not over 800 tons displacement, about the size of the Gloucester and Scorpion, the draught not exceeding 11 ft. in a single screw boat; twin screw boats of this size with draught reduced to 9 ft. would be very serviceable, as proved in the present case, for harbor and river work. The next size to be of about 400 tons displacement, about the size of the Hist, Eagle, and Hornet, twin screw vessels of 7 to 8 ft. draught, intended for sea service as pickets. The third size, for harbor patrol service, to be of about 200 tons and 6 ft. draught, designed for smooth water, carrying a light armament and limited supply of coal. A speed of 15 knots would suffice for this service, but they should be capable of towing a vessel.

The requirements here set forth are in a general way but the theoretic qualities of the converted yacht, not fully realized now in any one vessel, but easily obtained in a special design. To the specialist in torpedo boat design or to the yacht designer, the problem would be a simple one. On the one hand the demand for very high speed, approaching 30 knots, with its egg shell construction and numerous limitations, is entirely eliminated; and on the other the numerous and conflicting requirements of the private owner as to amount and disposition of space are replaced by fewer and simpler ones. A vessel of this type could be built for far less than either the torpedo boat or the converted yacht; she would fulfil her own special mission, covering a very wide range of usefulness, better than either; she could be handled to advantage by the average crew, not necessarily experienced men; she could, when not needed, be laid up for an indefinite time, ready for service at a few days' notice; and when thus laid up she would not be subject to the double deterioration of the torpedo boat; physical in the actual disintegration of her light frames and plating, and technical in the outbuilding by vessels of newer design and higher speed. As practice vessels for the Naval Militia for short intervals in the summer, a purpose for which it has been suggested yachts might be borrowed, these vessels would be superior to either the yacht or the torpedo boat. They would carry a larger number of men than the torpedo boat, their armament of 4 in., 5 in. and 6 pounder rapid fire guns would be better suited for practice than the two extremes of the torpedo and the 1 pounder; and while the larger sizes would be capable of practice cruises at sea, the smaller with their limited draught would be well adapted for such work as the exploration and study of local waters, as now carried on by the Naval Militia.

With suitable designs once completed for each size of vessel in the class, there would be no necessity to modify them with each new improvement that gives speed; and the attention of the designer might be concentrated upon the perfecting of details and such a reduction of engines and other parts to established standards as would minimize the cost of construction,

and also make it possible to add to the class very quickly in the case of an emergency.

An examination of the smaller types of gunboats in use by other nations would disclose many interesting points; but it is not necessary to go outside the immediate experiences of the past six months for several important conclusions. The conditions of coast defense, as thus indicated, involve certain work which is not within the legitimate field of the existing gunboat class, or of the high speed torpedo boat; and which can only be done imperfectly and at great expense by means of the conversion of the steam yacht. A special class of vessel fully fitted for this work can be constructed at a comparatively moderate cost; and, once provided in sufficient numbers, can be laid up for an indefinite time in a condition for almost immediate use.

The developments by Signor Marconi in wireless telegraphy have excited a considerable degree of enthusiasm in marine circles, and experiments have already been made on the Great Lakes of this country, in the Italian Navy and elsewhere, with a view to adapting Marconi's apparatus to the transmission of signals between ship and ship and between ship and shore. Clearly intelligible signals have been transmitted 1 1-2 miles on the Great Lakes and between South Foreland Lighthouse, England, and the French coast. M. Pasqualini, chief electrician of the Italian Navy, is reported as having developed a modification of Signor Marconi's apparatus by means of which signals were transmitted without trouble over a distance of 24 miles. All of the apparatus thus far devised, however, involves the disadvantage of extreme delicacy of adjustment, and for long distances (5 miles and upward) inconveniently long vertical conductors must be carried up into the air. M. Pasqualini's experiments seem to indicate that the principle is electromagnetic induction, pure and simple.

AMERICAN SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

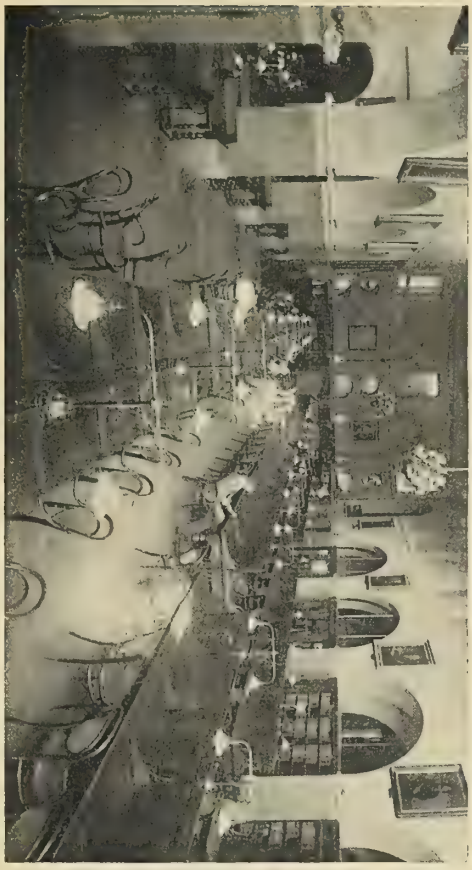
SCHOOL OF MARINE CONSTRUCTION, SIBLEY COLLEGE, CORNELL UNIVERSITY, ITHACA, N. Y.

A Comprehensive Account of the Special Instruction in This Branch of Engineering Given at This American University—Widely Famed for Its Courses in the Mechanic Arts.

In the beautiful lake region of western New York there is probably no more picturesque location than that occupied by Cornell University. As the train, which carries the visitor to the college city of Ithaca, suddenly rounds a curve the buildings of the famous University on the hilltop come into view; then, a few rods farther on, the valley opens out before him, with the little city in the foreground, and beyond lies beautiful Lake Cayuga, narrow because its length is lost in the horizon, and bordered by green hills which slope gently to the water's edge.

VIEW OF THE CAMPUS, CORNELL UNIVERSITY, IN MIDWINTER.

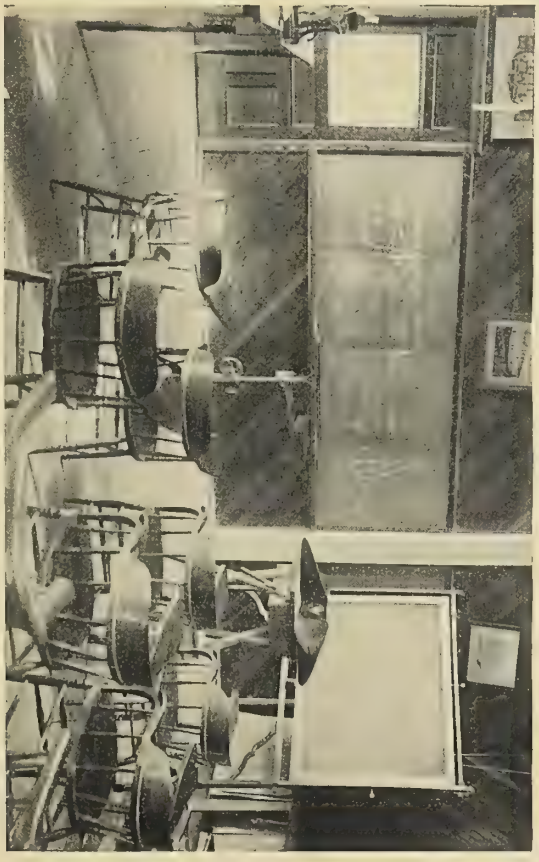
Ithaca is a typical college town, quiet and reposeful, with a dignity which is the result of a sense of proprietorship in a great American university. Cornell University has not the history behind it which other universities can take pride in, but it is probably fortunate in this, as can be readily understood. The doors of the University were opened to students in 1868 as the representative in New York of institutions incorporated under the general provisions of the Land Grant act of 1862. By the terms of this act the leading object in institutions taking advantage of its provisions should be to teach such branches of learning as are related to agriculture and the mechanic arts. Due to this requirement of the Act of Congress,



Library Building Cornell University.

Interior of Library—General Reading Room.

EXTERIOR AND INTERIOR VIEWS AT CORNELL UNIVERSITY.



Sibley College Buildings.

Recitation Room, Marine School Sibley College.

made more practicable by the generous gifts of the late Hiram Sibley, instruction in the mechanic arts became from the start one of the leading features of the institution. Seeing that the mechanic arts as now practised are the outgrowth of modern scientific effort, the advantages of building up an institution on modern lines, and with modern ideas only to be consulted, are very apparent. It was an act of creation rather than evolution, and in the material respects of location, convenience and adaptability to modern ideas, there was the grandest opportunity for an intelligent disposition of things, undisputed by tradition, precedent or vested rights.

After its foundation the college work, so far as mechanic arts were concerned, carried along upon the original lines until the year 1885, when the various departments concerned in this work, which from the first had been known collectively as Sibley College, were organized more distinctively upon an engineering basis, with the present Director, Dr. R. H. Thurston, in charge. The experience of Dr. Thurston as an officer of the U. S. Naval Engineer Corps during the Civil War, and later as a teacher at the U. S. Naval Academy, naturally led him to appreciate the importance, especially to American mercantile marine interests, of an oportunity for the special study of Marine Engineering and Naval Architecture on the part of those who were to be charged with the duty of designing, building and operating the American mercantile marine. The original inception of such a school at Cornell University may therefore be said to date from 1885, when the present Director of the College took charge.

The broad policy of the administration of Sibley College has constantly been: To provide, not only for the proper undergraduate courses in Mechanical Engineering, but also to establish, as they may be called for and as the progress of the University may permit, a system of advanced schools of special branches of Mechanical Engineering.

The time seeming ripe for such action, the School of Marine Engineering and Naval Architecture was organized as the first of such special schools, by order of the Board of Trustees, October, 1890.

SCHEME OF INSTRUCTION, ETC.

The object of this school is to provide courses of instruction and opportunities for research in such special branches of engineering as relate to the design, building, powering and propulsion of vessels of any and all types. Such courses naturally fall under the heads: (a) Naval Architecture. (b) Marine Engineering.

These two subdivisions are closely inter-related, and of the courses of study offered, many are common to both. Outside of these each branch is specialized in its own direction, the Naval Architect being, of course, more especially interested with the ship, and the Marine Engineer with the engine and the application of its power to the propulsion of the ship.

The instruction in the courses in Marine Engineering and Naval Architecture is given by Professors Durand and McDermott, who have held their present positions from the foundation of the school, and whose previous professional training and practical experience as a preparation for such work cover periods of from ten to twelve years each, for the former in the U. S. Naval Engineer Corps, and for the latter as Naval Architect to one of the leading shipyards on the Clyde. These professors devote their entire time to the work in these subjects, and specially aim to make the instruction thoroughly practical in its nature, while at the same time due attention is given to the theoretical or scientific, and to the development of a close relationship between the two, thus laying a broad foundation for the intelligent study of the subject both as a science and as an art.

The instruction is given largely by lectures, or by lectures as supplementary to mimeograph notes and text-book. Frequent quizzes and occasional written essays on the subject matter of the lectures insure a proper understanding of the subject on the part of the pupil. In the course in Marine Engineering the descriptive study is based chiefly upon a large collection of blue prints representing in detail the best practice in mercantile and naval designs, while a course of auxiliary reading is assigned, including a half dozen of the best modern books treating of the subject. Much of the time of the student is spent in "application" work, consisting of computation and drawing, all of which is under the personal direction and frequent supervision of his instructor in the subject. The methods of instruction and the courses of study, hereafter enumerated in this article, are the result of a continuous development during the past eight years.

That special training in Marine Engineering and Naval Architecture is of value in the modern shipyard seems to be proven by the fact that most of the students thus trained have found employment in their chosen field, either in private shipyards or as assistant draughtsmen under the Navy Department Bureau of Construction and Repair. Some have already reached positions as chief draughtsmen, and in all the leading yards of the Atlantic coast and the Great Lakes representatives may be found, many of whom are doing work in connection with the more important recent designs, both for the Navy and for the American mercantile marine.

The university year, which is the same for all the colleges, runs from about Sept. 25 to June 15, and is divided into three terms, with about a week's intermission between, at Christmas and at Easter.

The University provides no dormitories, except for its 200 women students, and the men find homes in the various boarding houses which abound on the side hill between the Campus and the business part of the town, or in the various Greek letter fraternity lodges, of which there are nearly thirty in active life.

That "All work and no play makes Jack a dull boy" is nowhere more thoroughly believed than at a modern university, and the long, almost unbroken, history of victories in boating standing to the credit of Cornell, together with the good showing which her teams have made in base ball, foot ball, and other intercollegiate sports, show that these things receive their due attention as well as Greek and Mathematics, Science and Engineering, or Law and Psychology.

The situation of Cornell University in a small town in one of the most beautiful and picturesque parts of

Sibley Students in the Foundry.
Main Machine Shop at Sibley College.

Students at Work in the Joiner Shop.
Forge at Sibley College.

PRINCIPAL WORKSHOPS FOR PRACTICAL INSTRUCTION AT CORNELL UNIVERSITY.

the lake region of western central New York gives it special advantages from the educational standpoint. The location on the crest of a hill, about 400 ft. above the city of Ithaca, and overlooking Cayuga Lake on the north and the city and distant hills on the west and south, furnishes a never failing source of inspiration in itself. The open country lying back of the Campus and the lake within easy reach on the north give abundant opportunity for physical exercise and development, while in the town is to be found everything needed for comfort and convenience, without the distractions which are necessarily found in larger cities.

But to return to the School of Marine Construction, it is a significant sign of the times that the ship builder, the ship owner, the political economist and the financier are all agreed that the American mercantile marine is sadly in need of new life and vigor, and that its rehabilitation is nothing short of a national duty; though they are by no means so well agreed as to the means necessary to the accomplishment of this purpose. All will agree, however, that one of the important means to this end is a shipyard wherein with the minimum of expense, both in time and money, there can be produced with certainty a ship which shall, on the least expense for operation, fulfil the various specified conditions of design. In the present condition of the art of shipbuilding, and with active foreign competition in view, such results are not to be obtained by haphazard methods, and herein lies the great responsibility, and yet opportunity, of the School of Marine Construction. It is to the students of such institutions that the country must look, largely, for the restoration of America to the leading position among shipbuilding nations.

COURSE OF STUDY.

The course of study at Cornell recognizes the fact that the Naval Architect and Marine Engineer must have the broad training which lies at the foundation of all branches of the engineering profession, and that he should have, in addition, much of the special training which relates to branches other than those in his own chosen field.

With this end in view, the first three years of the course are, with slight exception, the same as for the regular training in Mechanical Engineering. During the third year the Naval Architect begins to specialize in ship drawing, while the Marine Engineer continues the regular course. During the fourth year a part of the work for both is the same as in the regular Mechanical Engineering course, while a part is distinctively marine. The four years' course thus planned leads to the degree of M. E., and constitutes a strong course in Mechanical Engineering, with sufficient specialization in marine work to enable the student to appreciate intelligently the leading problems in this field.

The amount of time which the student may devote to drawing, design, and similar work representing the application of the lectures is limited only by his ability and the time at his disposal. A certain amount of such time is required, but more may be given with corresponding benefit, if the time is available. To take advantage of this provision many students, by working in the shops during vacations, and in various other ways, work ahead of the course and devote the additional time at their disposal to the subjects in which they are specializing. In this way it is not uncommon for a student to practically double the amount of time available for drawing, design and similar "application" work.

In addition to this work, given in the undergraduate course, a post graduate course is given, in which the student gives his whole time to marine work, and in which the undergraduate lines of study are carried on, and additional work of an advanced character is introduced. The student who successfully completes the graduate year should be as well fitted for an intelligent introduction into the practical work of his profession as he can hope to be outside of the school of actual experience. The degree of M. M. E. may usually be taken at the end of a year's post graduate work.

In the foregoing the course in general is outlined, and now the entrance requirements call for consideration, as well as the subdivision of time in the course, and a synopsis of the marine course will also be of special interest.

ENTRANCE REQUIREMENTS.

The following subjects are required for admission: English, Physiology and Hygiene, History (the student must offer two of the four following divisions in History: (a) American; (b) English; (c) Grecian; (d) Roman), Plane Geometry, Elementary Algebra, Solid Geometry, Advanced Algebra, Plane and Spherical Trigonometry and *either* French or German.

The undergraduate course as at present specified requires about 226 hours of university credit, distributed over four years of three terms each, a term consisting of about twelve weeks' work. One hour of university credit means one lecture or recitation per week for a term. In counting drawing and shop work, three hours, and in counting laboratory work two and one-half hours per week for a term are required for one hour of credit.

The distribution of the work for the marine course may be summarized in the following table, which is again represented graphically in the diagram printed hereafter.

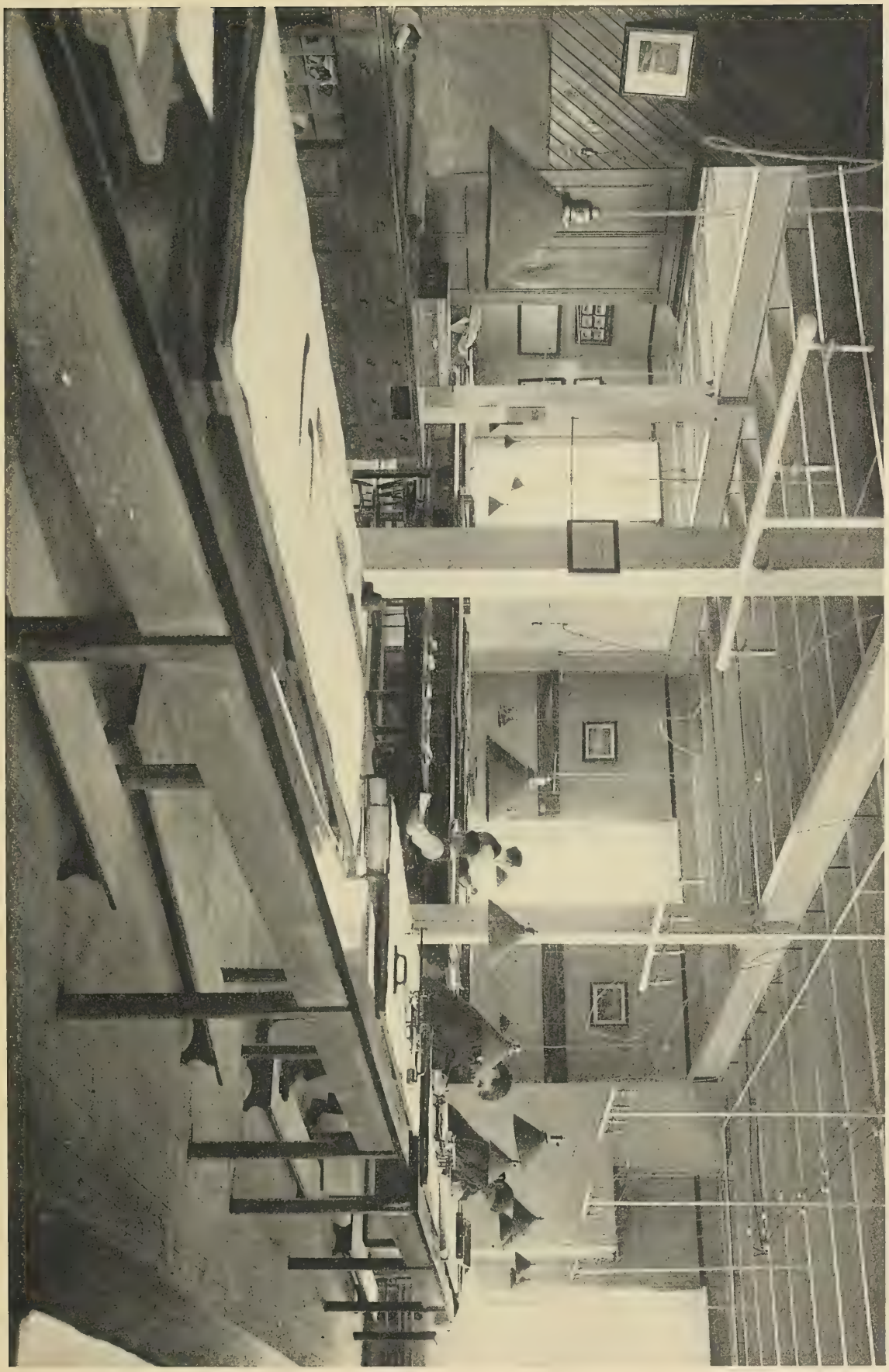
	SUBJECT OR ALLIED GROUP OF SUBJECTS.	HOURS OF CREDIT.	PERCENTAGE SUBDIVISION.
(1)	Mathematics and Mechanics, including Descriptive Geometry	36	16.0
(2)	Modern Language	9	4.0
(3)	Physics and Chemistry	36	16.0
(4)	Drawing	15	6.6
(5)	Electrical Engineering	10	4.4
(6)	Mechanical Engineering (general)	41	18.0
(7)	Shopwork	31	13.7
(8)	Marine Courses	48	21.0
		226	

In the graduate year the time is practically all spent in marine work, or in work closely allied to it, along advanced lines, as indicated in the synopsis of the studies below.

Synopsis of Courses.

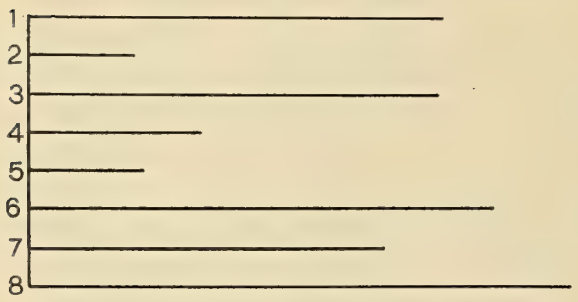
NAVAL ARCHITECTURE.

The leading features of this course are as follows: Methods of approximate integration and their appli-



DRAUGHTING ROOM OF THE SCHOOL OF MARINE CONSTRUCTION AT SIBLEY COLLEGE, CORNELL UNIVERSITY, ITHACA, N. Y.

cation to the calculations arising in naval architecture; theory of the planimeter and integrator; integral curves and theory of the integraph; the various form coefficients, their significance and relationships; computations for displacement, tons per inch, centers of buoyancy, metacenters, moment for change of trim, wetted surface, etc. In connection with these the usual curves and graphical representations are laid down. Careful attention is given to the relationships



DISTRIBUTION OF WORK FOR MARINE COURSE.

existing between these various geometrical quantities, and a thorough foundation is laid for the intelligent study of any portion of the immersed body so far as may relate to areas, volumes and centers of gravity.

Following these subjects the foundation is laid for the theory of stability, and representative methods in use are explained and illustrative computations are made.

The theory of the strength of the ship, considered as a complex girder, is developed in detail, methods of computation are derived, and actual computations are carried out in the work under the course of Ship Construction and Design.

The subjects of resistance, propulsion and powering are considered in great detail, and the most approved methods are given and illustrated by the results of experimental research.

Special attention is paid to the laws of comparison and to methods of analyzing the results of experimental and trial data.

The theory and design of the screw propeller receive careful attention, and the most approved methods are illustrated by numerous examples and illustrative problems.

In the advanced course, in addition to new subjects, several topics already studied are taken up and studied again in a more general way or from a more advanced standpoint, the object being the more complete preparation of the student through such work for the intelligent treatment of the various problems which continually arise in both the science and art of marine construction. The work consists partly of lectures, partly of directed courses of reading, and partly of personal study on the part of the student under the direction and aid of the professor in charge. Among the topics thus studied are these: stability by special methods, advanced stability theory, water in bilged compartments, added or subtracted weights, inclining experiments, liquid lading, launching conditions, wave motion, oscillations of ships in still water and waves, trial trips and their analysis, theory of the rudder and of gyrations, special problems in stability, stress and strain, resistance, propulsion.

SHIP CONSTRUCTION AND DESIGN.

This course, which extends throughout the year, opens with a series of lectures on ship building, in which the innumerable details of construction of steel and iron vessels, their fittings and equipment, are fully described.

Starting with a description of the work involved and the methods employed in the laying down and fairing of the lines of a vessel in the drawing room and mould loft, the rules of the leading registration societies or associations—*American Bureau of Shipping, United States Standard, British Lloyds, Bureau Veritas, etc.*—for the construction and classification of vessels are next taken up, the scantlings or sizes of the different parts of the steel and iron structure of vessels, and the mode of procedure in obtaining them peculiar to each society, are carefully examined and compared in detail.

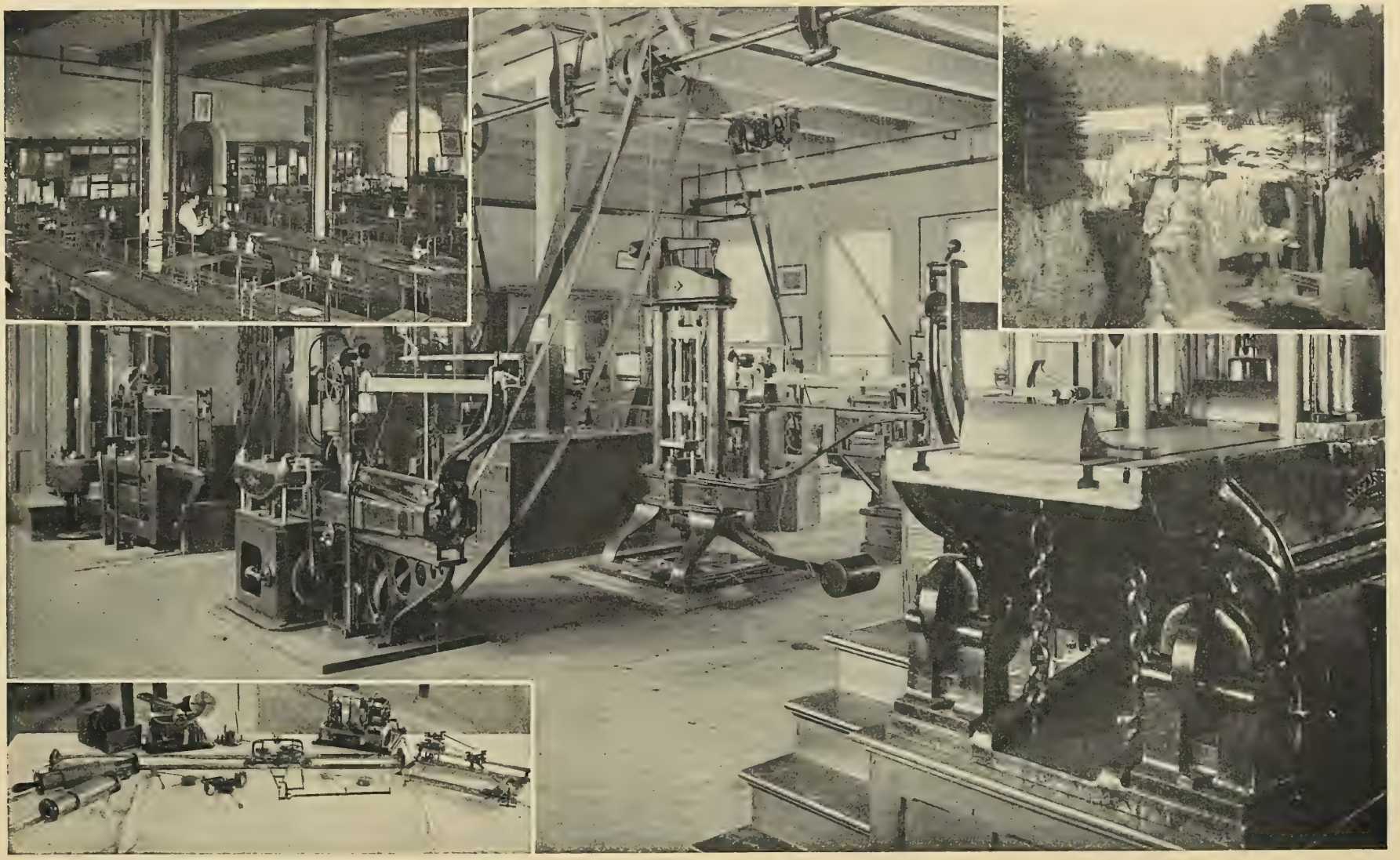
Following this the lectures deal with the different operations in the shipyard, connected with the preparation, assemblage and fastenings of the various parts of the ship in all the stages of construction, including the preparation of the scrive board, preparing the ground in way of building slip, laying of keel blocks, laying of wood decks, ceiling, building of houses for passenger and other accommodation, fittings, cementing and painting. Special attention is devoted to a description of the leading types of ship machines for the handling of cargo, anchor gear, steering gear, pumping, drainage, ventilation, lighting, systems of telegraphy, life saving appliances, and other details of general equipment and outfit. The application of steam, compressed air, electrical and hydraulic power to the above appliances is dealt with in the general discussion.

The series of lectures concludes with a detail of the operation of launching, docking, placing machinery, masts and other heavy weights in position, and the general completion of the vessel.

Supplementary to and illustrative of the work embraced in the above lectures, the following drawing room exercises are performed as far as time and skill of the student will permit: Laying down and fairing a set of lines of a vessel to fulfil given geometrical conditions. Preparation of mid-ship section of same vessel, showing scantlings according to the rules of the aforementioned registration societies. General arrangement plans showing disposition of machinery, cargo holds, coal stowage, passenger and crew accommodation and general equipment. Computations of the different geometrical quantities for verification in comparisons with those stated in the given conditions.

In performing these exercises close personal supervision is given and the salient features of the work in general application are pointed out and discussed.

Having become familiarized with the art of ship construction, and gained a thorough knowledge of the fundamental principles upon which the science is based, from his studies in Naval Architecture, which are carried along on parallel lines, the student is prepared to take up the problem of Design.



One of the Chemical Laboratories. *A View of the Machines in the Testing Laboratory.* *Experimental Canal Above the Falls, Now Under Construction.*

Measuring and Calculating Instruments Used in the Marine Course.

SOME OF THE FACILITIES FOR EXPERIMENTAL WORK AT CORNELL UNIVERSITY.

This division of the course is dealt with in a series of lectures under the following heads:

Weights: Hull, outfit and equipment; machinery; fuel; passengers, crew, and their effects; stores, provisions and fresh water. The most approved methods of estimating the above weights are carefully considered.

Dead Weight and Stowage: Of cargo of different classes peculiar to the various trades are fully dealt with, as also that of coal, oil and other fuels.

Speed and Power: The subject of speed is given special attention, and the relationship between speed and power is discussed from the designer's standpoint.

Stability: The question of stability, as found in every day practice, receives careful treatment. The determination, experimental and otherwise, of the centers of gravity of vessels, their machinery and loads in different conditions of service, are explained and discussed.

Trim: The trim of vessels is dealt with in similar detail.

Safety: The considerations which are involved under this important head are fully examined—watertight subdivision, duplication of machinery, fire annihilation and pumping, freeboard, stability, and other branches of the subject are passed in review, and the part which each takes in the general solution of the problem is carefully considered.

Strength: The strength of a ship, in its separate details and as a completed structure, is taken up and critically examined.

Finances: The cost of production is next taken up and different systems of estimating the cost of vessels, their machinery and outfits complete, are explained in detail; the effect which the several conditions have upon the cost are carefully pointed out from both the ship builder's and the ship owner's point of view.

Having passed in review the underlying principles and conditions of design in detail, under these heads, the concluding lectures deal with the selection of the most suitable dimensions to fulfil the conditions, in whole or in part, as they are met with in the ordinary demands of the commercial marine.

In the drawing room the work embraced in these lectures is applied and illustrated, each student preparing a completed design to fulfil a given set of conditions.

As a conclusion of the completed course, one or more lectures, as may be found necessary, are given upon the organization and administration of ship and engine building establishments, considered technically and financially.

In the advanced or post graduate course in ship design the student progresses along lines of original thought and investigation.

MARINE MACHINERY.

The subject is studied first from the descriptive standpoint, illustrated by large numbers of drawings and prints representative of the best modern practice in both naval and mercantile designs. The various types of marine boilers, including the various forms of tubulous or water tube boilers, are examined and their peculiar characteristics, advantages and limitations are pointed out. Special note is taken of corrosive and deteriorating causes, and the best means of prevention. Attention is also given to piping, the various methods of forced draft, special fuels, boiler auxiliaries, evaporators, feed-water heaters, etc., with hints on general boiler care under the conditions of use. The influences of the peculiar conditions of marine boiler practice upon the general principles of boiler design are then examined, coupled with analyses of the designs of boilers representing the best practice, and followed by designs of an original character by the student.

In a similar manner a study is made of the peculiar conditions under which the marine engine is obliged to work, and of the advantages and disadvantages of the different types and forms. The influence of these peculiar conditions on general engine design is noted, and analyses are made of several designs representing modern practice. These are followed by numerical designs of an original character for both main engine and auxiliaries, supplemented by actual drawings as far as the time will permit.

Special attention is paid to vibrations and the balancing of marine engines; the derivation of the probable indicator cards for a multiple expansion engine from the valve events and the cylinder, receiver, and clearance volumes; and the derivation of curves of turning moment and their modification by the inertia of the moving parts. In carrying out this work in design a detailed examination is made of the problem of balancing and crank effort, including the influence of inertia, using both graphical and numerical methods of computation. All valve gears are designed and the results analyzed by the aid of a specially designed valve gear model which gives accurately the movements of the various parts, and the consequent movement of the valve. For the machinery thus designed, general specifications of the whole and detailed specifications for at least a part are prepared, in order to familiarize the student with the forms and phraseology employed.

MARINE ENGINEERING.

This course is a continuation of the course on Marine Machinery, and consists of an advanced study of various special topics connected with the design, construction and efficient management of marine machinery. The designs are carried on to include detail drawings of the more important parts of the engine and auxiliaries. One or more general arrangement plans are also prepared, showing the main and principal auxiliary machinery, boilers, uptakes, smoke pipes, principal steam and water pipes, coal bunkers, store rooms, etc. Lectures are given in these and kindred topics, and special subjects for personal study and research are assigned, the better to develop independence of thought and method and acquaintance with engineering literature.

SEMINARY.

This exercise consists of a weekly meeting, in which the current technical and professional literature is discussed, with such other special topics as may seem timely. The current literature is assigned among the members of the class, abstracts of articles and notes of interest being presented at the seminary for common information and for free discussion. The object is to provide a means for keeping up with the

world's progress in professional matters, and an informal meeting for the ready interchange of ideas among those interested in this line of work.

THESIS.

The subject of the graduating thesis in this school may be either the design of a ship or her machinery, or a special investigation of some particular topic in this field. If a design is chosen, an early choice of subject makes it possible to apply much of the illustrative work of the course to the thesis, thus making it more complete than it could otherwise be made in the time usually allowed.

EQUIPMENT AND FACILITIES FOR INSTRUCTION.

The school occupies commodious and well lighted quarters, consisting of drawing room, lecture room, offices and store rooms, and is well equipped with all material aids for the study of Marine Construction. Special attention is given to the varied computations which form so large a part of the work of the naval architect, and the student is drilled from the first in the use of the most approved mechanical aids, such as the planimeter, integrator, integraph, comptometer, slide-rule, etc. Especial attention is given to the use of the slide-rule in computations, the school being well supplied with "Fuller" rules, and every effort is made to give to the student sufficient practime to make him familiar with the more important mechanical aids as they may be applied in his every day work. At the same time purely numerical computations are by no means neglected, and special attention is given to accuracy and rapidity in all work of this character. In addition to these instruments the school possesses a large collection of drawings, blue-prints, and photographs representing all varieties of marine construction and serving as valuable material for illustrative purposes.

During the past eight years an effort has been made to gather into the University Library the literature relating to marine construction, both in English and in the European continental languages, and both modern and historical. As a result the library is exceptionally complete in this department, containing in addition to practically all of the modern literature many rare books of great historical value and interest.

In addition to these items used in every day instruction, attention is also called to the new experimental tank or canal, a part of the extensive hydraulic laboratory just established under the charge of the College of Civil Engineering. This canal is about 350 ft. long by 16 ft. wide and 10 ft. deep. Arrangements have been made whereby the facilities here afforded may be made available for the purposes of this school, and it is hoped that in the near future the canal will be provided with the equipment needed for special research in the fields of resistance and propulsion.

SPECIAL STUDENTS.

An excellent feature of the college is the provision for the special admission of students who are not candidates for degrees. Such students may be admitted without examination to any of the courses. They must be not less than 21 years of age, and their training and preparation must have been such as to enable them to carry on with profit the courses which they propose to take.

Under these conditions, persons who may already have some knowledge of the subject, but who may wish to acquire a more exact knowledge of fundamental principles and approved methods, or who may wish to pursue special studies on certain topics connected with the subject, may spend with profit a year or more as a special student in this work. While such students do not take a degree, they may be given a certificate of attendance, stating the amount and nature of the work which they have successfully completed. This gives a splendid chance for the *practical man* who has not had opportunity to follow up advanced theoretical work to take up such work and get the benefit of university instruction and facilities. Such a student who realizes his needs and the extent to which they must be supplied usually makes an earnest and highly successful worker.

EXPENSES.

The tuition fee for all students is $125 a year. Books and laboratory fees amount to from $25 to $40 additional. The usual cost in Ithaca of board and lodging varies from about $4.50 to $7 per week.

COLLEGE AND UNIVERSITY.

Of Sibley College in general and the opportunities for the special study of mechanical and electrical engineering as introductory or supplementary to the marine courses, an entire article might be written. The accompanying photographs, however, will furnish an idea of some features of the equipment. Of special importance for the students of Marine Construction are the facilities for the study of the properties of materials provided by the testing laboratory with an equipment of upward of fifteen testing ma-

Lake Cayuga. *City of Ithaca.* *Cornell University.*

chines of capacities varying from 300,000 to 15,000 pounds, and including the Emery hydraulic machine exhibited under government auspices at the World's Columbian Exposition. Of a similar character is the equipment of the Department of Electrical Engineering in conjunction with the University Department of Physics, whereby are afforded unexcelled facilities for the study, both theoretical and experimental, of electrical generators, motors, and of electrical apparatus and equipment of all kinds.

Much might also be said of Cornell University as a whole, with its nine colleges, some fifty departments, and a teaching force of nearly three hundred professors and instructors. Among these various departments of instruction, those of Mathematics, Physics, Chemistry, Law, and Political Economy, furnish most valuable opportunities for the study of special topics of interest to the Marine Engineer and Ship Builder. These and all other departments of instruction are open to any student in the University, under the general restriction only that his previous preparation shall be sufficient to enable him to take up the work with advantage to himself.

Two large steamships for the Morgan Line, the *El Norte* and *El Sud*, were launched last month by the Newport News Shipbuilding & Dry Dock Co. They are sister ships and will cost $600,000 each. In dimensions they are as follows: Length over all, 406 ft.; beam, 48 ft.; depth, 33 ft. 9 in.; gross tonnage, 4,665 tons. The hulls of the ships are of steel throughout, and they will have three decks. They are rigged with two steel pole masts and necessary booms for handling cargo.

DISCUSSION OF THE PERSONNEL BILL RECENTLY PASSED BY CONGRESS.

BY DAVY JONES, A. B.

The Act to reorganize and increase the efficiency of the *personnel* of the Navy and Marine Corps of the United States, or, as it is better known, the Naval Personnel Bill, having been passed by Congress at its last session and approved on March 3 by the President, a brief outline of the circumstances leading up to the framing of such a measure, particularly in its bearing toward engineering in the Navy, as well as the bill's provisions as finally enacted into law, must prove of interest.

To those who have followed the gigantic strides and wonderful development of warship construction within recent years, it will not seem strange that an organization which rested mainly on sail power as a foundation must of necessity be obsolete. Sixty years ago warships were propelled by sails alone, and there existed no necessity for Engineers. With improvements in the steam engine came its gradual application to vessels as their motive power, but only at first as an auxiliary to sails in calm weather. Later, during the period of the Civil War and for years afterward, the conditions became reversed and steam was regarded as the principal motive power and sails as auxiliary. To-day sails have entirely disappeared from our warships as a propulsive power.

With this advancement in our ships to meet modern conditions, our *personnel* in its organization on shipboard has not kept pace. The long history of the sea shows nothing so steadfast, nothing which withstands the years so firmly, as naval law and custom which govern the duties of officers and men. Although for fully half a century steam has been a growing factor in naval science, the horse power of naval vessels increasing from the maximun of 1,000 in 1864 to 21,000 in ships of recent date, and with auxiliary machinery increasing from the scant half dozen engines of the *Monitor* to 175 steam cylinders in the *Columbia* type, the organization of our *personnel* remained practically as during the Civil War.

It is true the education of Line Officers has, in later years, been supplemented by a course in engineering, since in actual service a part of their daily duty is the handling of much of the auxiliary machinery, including dynamos, turret machinery and ammunition hoists, etc. Fundamentally, however, the old method of making a sailor prevailed, and, nothwithstanding the slight engineering training given, no real effort has been made until recently to fit the *personnel* to the modern *matériel*.

Under a naval organization, therefore, which was based on the needs of days when steam played an inconspicuous part, it could not be otherwise than the varying interest of the two corps of officers—Line and Engineer—with their widely distant points of view, and ever increasing overlapping duties, should produce the conflict which has been waged between these branches of the Navy for more than thirty years. Discord was inevitable because the organization was irrational. Efficiency, as well as harmony, demanded a full recognition of the Engineer. The Line Officer, however, justly proud of the past achievements of his corps, was disposed to yield none of his military functions to the newcomer; while the Engineer, trained in the same school, and side by side with Line Officers, could not but see injustice in a system which gave him a vast responsibility in care of machinery of all types, with the control, in some cases, of half the crew, and yet refused him the right to command enlisted men, classed him as a non-combatant and denied him the military title which for centuries has been associated with the fighting man.

Some idea of the bitterness of this Line and Staff struggle may be gleaned from the writings of Governor Roosevelt, who, after appointment as Assistant Secretary of the Navy in 1896, quickly recognized the danger to a military service thus divided against itself. It was in part due to his persistent efforts that a solution of the problem was reached. He says:

> Not long after I became Assistant Secretary of the Navy my attention was called, by a number of occurrences, to the fact that there was much friction in the *personnel* of the Navy between the Line Officers and the Engineers. Its was not so much that any one officer, or set of officers, made charges against another, but that the point of view on both sides showed a state of affairs which, if allowed to continue, would certainly be detrimental to the efficiency of the Navy. It was very unpleasant to find officers of the highest standing displaying toward brother officers of a different corps a feeling of jealousy, which was emphatically unworthy of a service with such noble traditions, and of officers so single minded in their devotion to the flag.
>
> This state of affairs demanded investigation, in order to ascertain whether something could not be done to do away with the conditions that had called it into being, and to make every

officer in fact, as he already was in desire, an active helper in the upbuilding of the efficiency of the Navy.

Consultation with members of the Naval Committees of the Senate and the House revealed the fact that the trouble was chronic, and had causd serious damage to the Navy in Congress, for every Congressman who was doubtful as to the policy of upbuilding the Navy was apt to be changed into a positive foe of the Navy by this "Line and Staff" fight.

In November, 1897, the Secretary of the Navy organized a Board of Officers, with Assistant Secretary Roosevelt as President, for the purpose of considering measures calculated to promote harmony and increase efficiency in the naval service, with special reference to the Line and Engineer Corps. The Board was composed of seven Line and four Engineer Officers, and may be considered fairly representative of the two corps, a majority of the officers having been in the Navy over thirty years, while each side had one officer to represent the younger men. As the Engineers had long contended that they were not accorded a proper status in the Navy, they were called upon by the Board for a statement of their claims, and these were submitted substantially as follows:

1. The right to exercise military command over the men of the Engineer department. It will surprise civilians, no doubt, who are unfamiliar with Naval laws and regulations, to learn that such a claim as this should be necessary; but existing laws and regulations have heretofore explicitly denied the right of command to all Staff Officers, which includes Engineers.
2. The right, under proper circumstances, to command any enlisted man. With the right of command denied to Staff Officers there have been cases in which it was attempted to subordinate a commissioned Staff Officer to an enlisted man.
3. Actual instead of "relative" or "trade dollar" rank, in order that the legal right to command enlisted men should not be questioned.
4. The military title indicative of this rank, but with the name Engineer Corps added, in order that there might be no confusion with Officers of the Line, and following the custom of the Army with respect to officers of the various Corps and Departments.

The Board thoroughly discussed these several claims, and while some of the propositions were considered with a certain degree of approval, it may be said in general terms that the claims met with unanimous opposition of the Line Officers composing the Board. It thus seemed that a deadlock had been reached at the very start, since one side totally disagreed with what the other considered as vital. A solution, however, came immediately afterward in a proposition from one of the Line Officers to abolish the separate Corps of Engineers and to have all engineering duties performed in the future by Line Officers. This proposition, after several days' thorough discussion, was adopted, although it can hardly be claimed as originating with the Board, since there have been in the past many who have given close study to the personnel question and could find no other satisfactory solution. It is worthy of note, too, that the vote of the Board on such an unmatched innovation was practically unanimous, there being but one dissenting voice.

Proceeding, therefore, on the lines of amalgamating the Deck and Engineer Officers into one homogeneous corps, as the distinguishing feature, the Board framed for Congressional action a bill to bring this about with, as far as possible, even justice to all officers of both corps.

As to the reasons actuating the Board in recommending a solution to reconcile all differences by such a radical change, it is of interest to quote from the report of Governor Roosevelt, submitted to the Department soon after the Board's labors were completed. He says, in part:

As was natural, in groping about to remedy a new evil caused by new conditions, it has seemed very difficult to hit upon the right expedient. Yet in reality the remedy is simple and obvious. All that is needed is to make the Line Officer and the Engineer the same man, by throwing both corps into one; or, in other words, to do away with the Engineers as a separate corps by requiring all Line Officers hereafter to possess that knowledge, both theoretical and practical, of steam engineering and mechanics which it is absolutely indispensable for the thoroughly efficient modern Line Officer to show.

Every officer on a modern war vessel in reality has to be an Engineer, whether he wants to or not. Everything on such a vessel goes by machinery, and every officer, whether dealing with the turrets or the engine room, has to do Engineer's work. There is no longer any reason for having a separate body of Engineers, responsible for only a part of the machinery. What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern Line Officer. The midshipmen will be grounded in all these duties at Annapolis, and will be perfected likewise in all of them by actual work after grduation. We are not making â revolution; we are merely recognizing and giving shape to an evolution, which has come slowly but surely and naturally, and we propose to recognize the Navy along the lines indicated by the course of the evolution itself. . . .

On the fighting ship the fighting man must stand supreme; only he must know how to handle his tools, and must change as the ship changes, so that precisely as he once knew about sails, now he must know about engines. There can be no divided command. Only one man can exercise it; but he must be thoroughly fitted for it. It is not necessary that he should possess the manual dexterity whether of the topman or of the engine driver; but he must have passed through the training which will enable him to oversee and direct their work.

A change like that which took place two hundred years ago must take place now. As then, the sailor man who knew only how to handle a ship had to be merged in the trained officer, while the sea soldier who had once commanded his troops either ashore or afloat became also a sailor man, so now the Line Officer and the Engineer must become one. . . .

Of course, such a proposition naturally meets opposition. The old Line Officer wags his head at the thought of the new duties to be learned, just as one of Blake's lieutenants, in his fierce battles with the Dutch and Spaniards, would have wagged his head if told that he ought to know how to stand his trick at the helm or to handle the rigging; while the old Engineer Officer, untrained to military command, disbelieves in any but one of his own kind being able to acquire the knowledge of his profession. Nevertheless, the difficulties in the way of realizing the proposed scheme are in reality altogether shadowy. The Engineers are now taken from precisely the same class of men, with precisely the same ideas, as are the Line Officers, and when their duties are made those of Line Officers they will show precisely the same capacity for command. The Line Officers in turn are already of necessity continually doing more and more engineering work. Electricity, for instance, is in the Navy purely in the hands of Line Officers, who have developed it to a high degree; while the Ensigns on our torpedo boats, who are in fact, although not in name, detailed as Engineers aboard them, are having a training which guarantees their thorough efficiency hereafter in the engineering part of their profession.

In short, it is absolutely essential that the best naval officer of the future shall be proficient in engineering. . . .

To sum up, we must disregard the prejudices of the old style Line Officer and old style Engineer, precisely as two centuries ago it was necessary to disregard the prejudices of those who would have kept separate the functions of the man who fought the ship and the man who sailed her.

While amalgamation of the Line and Engineer Corps is the most radical and far reaching feature of the personnel bill, the measure embraces as well other matters of signal importance to the Navy. The essential points contained in its provisions may be briefly summarized thus:

1. Amalgamation of the Line and Engineer Corps.
2. Regulated flow of promotion for Line Officers.
3. Promotion to commissioned rank of deserving Warrant Officers.
4. Adoption (for all sea-going corps) of Army pay, rank for rank.
5. The establishment of a new grade of Warrant Officers for the mechanical branch of the service.
6. Enlistments to be hereafter four years, instead of three, with provision for retirement of enlisted men after thirty years' service.
7. Reorganization and increase of the Marine Corps.

Owing to the fact that Engineer Officers were appointed under different laws, with different systems of training, it seemed impossible to frame any one general provision which would apply with fairness to the 176 officers comprising the whole corps. It was found necessary, therefore, to cover the details of amalgamation by the following six sections:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the officers constituting the Engineer Corps of the Navy be, and are hereby, transferred to the Line of the Navy, and shall be commissioned accordingly.

SECTION 2. That Engineer Officers holding the relative rank of captain, commander and lieutenant-commander shall take rank in the Line of the Navy, according to the dates at which they attained such relative rank. Engineer Officers graduated from the Naval Academy from 1868 to 1876, both years inclusive, shall take rank in the Line next after officers in the Line who graduated from the Naval Academy in the same year with them: *Provided,* That when the date of a Line Officer's commission as captain, commander or lieutenant-commander and the date when the Engineer Officer attained the same relative rank of captain, commander or lieutenant-commander are the same, the Engineer Officer shall take rank after such Line Officer.

SEC. 3. That Engineer Officers who completed their Naval Academy course of four years from 1878 to 1880, both inclusive, shall take rank in the Line as determined by the Academic Board under the Department's instructions of December 1, 1897, and Engineer Officers who completed their Naval Academy course of four years in 1881 and 1882 shall take rank in the line as determined by the merit roll of graduating classes at the conclusion of the six years' course, June, 1883 and 1884: *Provided,* That those Engineer Officers who were appointed from civil life, and whose status is not fixed by Section 2 of this act, shall take rank with other Line Officers according to the dates of their first commissions, respectively: *And provided, further,* That the Engineer Officers who completed their Naval Academy course of four years in 1881 and 1882 shall retain among themselves the same relative standing as shown on the Navy Register at the date of the passage of this act.

SEC. 4. That Engineer Officers transferred to the Line who are below the rank of commander, and extending down to, but not including, the first engineer who entered the Naval Academy as cadet midshipman, shall perform sea or shore duty, and such duty shall be such as performed by Engineers in the Navy: *Provided,* That any officer described in this section may, upon his own application, made within six months after the passage of this act, be assigned to the general duties of the Line, if he pass the examination now provided by law as preliminary to promotion to the grade he then holds, failure to pass not to displace such officer from the list of officers for sea or shore duty such as is performed by Engineers in the Navy.

SEC. 5. That Engineer Officers transferred to the Line to perform Engineer duty only who rank as, or above, commander, or who subsequently attain such rank, shall perform shore duty only.

SEC. 6. That all Engineer Officers not provided for in Sections 4 and 5 transferred to the Line shall perform the duties now performed by Line Officers of the same grade: *Provided,* That after a period of two years subsequent to the passage of this act they shall be required to pass the examinations now provided by law as preliminary to promotion to the grade they then hold, and subject to existing law governing examinations for promotion.

It will be observed that the transferred Engineer Officers are divided into three groups. The older men, who originally entered the service directly from civil life, all of whom are now above fifty years of age, and who naturally are beyond the time in life when a new profession can be undertaken with success, form the first section. These officers, numbering about twenty-five, are hereafter to be eligible only for engineering duty at Navy Yards and other shore stations. The middle group of seventy officers is composed almost entirely of graduates of the Naval Academy, and they are given the option of qualifying for the general duties of the new Line or of retaining engineering only. The third section, comprising the remainder of the corps, includes only those officers who were appointed as naval cadets and who, for three years in many cases and four years in some, pursued absolutely the same course at the Naval School as the younger Line Officers. All this group—alternation being the cardinal principle involved in amalgamation—are compelled to qualify in navigation, gunnery, etc., and are to be assigned to duty in the engine room and on deck alternately. If the bill is drawn on correct principles it is perfectly reasonable to require the younger officers of the third group to qualify for the general duties, because otherwise it would be to admit that the whole idea of the bill is a false one.

A close study of the intent of the provisions relating to amalgamation show that no violent changes are contemplated. The older Line Officers, who have had but a cursory course in engineering during their academic training at Annapolis, will still perform deck duty; the older Engineers will continue to be assigned to duty in connection with the machinery. For a year or two even the duties of the younger men will be but little altered. Then, as time goes on, the younger officers of the present Line will be required to stand watch in the engine room and the younger officers of the present Engineer Corps will have to familiarize themselves with the duties of Line Officers. In the meantime, in order that the naval officer of the future may be thoroughly qualified for his enlarged duties, it will be necessary to rearrange the course of instruction at the Naval Academy for all naval cadets, making it at least as good in engineering as that formerly taught to the Engineer division, a full description of which appeared in the last issue of this journal.

While, under the new organization, it is quite certain the unfortunate internal strife which has existed for years between former Engineer and Line Officers will be a thing of the past, the practical operation of the bill, so far as it affects the efficiency of the engineering department, will be watched with interest

both at home and abroad. Engineers in other navies, and especially in the British service, have long contended for a proper recognition and status of their corps, and the struggle is now going on with ever increasing bitterness. In the United Kingdom, however, the solution suggested differs from that adopted by us, inasmuch as a separate corps of Engineer Officers, with military rank and authority, is advocated; in addition, and for the purpose of maintaining full discipline in the mechanical department, it is considered necessary to vest in the Chief Engineer the right to inflict minor punishment on the subordinate *personnel* of the engine and fire rooms.

Rear Admiral Melville, the present Engineer-in-Chief of the Navy, in a letter recently published, has this to say of the amalgamation features of the bill:

The success of this radical experiment will depend entirely upon the officers in the Navy, and particularly upon those who were in the regular line before the amalgamation took place. If they—the younger ones particularly—will willingly and zealously undertake the work that was previously done by the officers of the Engineer Corps, I believe that this thing will work. If they do not, and if the tendency becomes wholly to absorb the younger Engineers into the Line and to fall back upon the newly created corps of Warranted Machinists for engineering duties, I think it will fail. In that event we shall be the unwilling witnesses of a repetition of history. For as soon as the Warrant Machinists discover that they are being relied upon as Engineers they will most surely advocate for the position that Engineers have in commercial life, in other navies, and, in fact, in all walks of life where mechanisms have influenced human industries.

The following sections fix the maximum numbers in the several grades of the new Line; abolish "relative" rank and the grade of Commodore on the active list; provide for a proper regulated flow of promotion in the Line; limit and reorganize the Corps of Constructors and confer certain privileges upon those officers with a creditable record who served during the Civil War after reaching the age of retirement:

SEC. 7. That the active list of the Line of the Navy, as constituted by Section 1 of this act, shall be composed of 18 rear-admirals, 70 captains, 112 commanders, 170 lieutenant-commanders, 300 lieutenants, and not more than a total of 350 lieutenants (junior grade) and ensigns: *Provided*, That each rear-admiral embraced in the nine lower numbers of that grade shall receive the same pay and allowance as are now allowed a brigadier-general in the Army. Officers, after performing three years' service in the grade of ensign, shall, after passing the examinations now required by law, be eligible to promotion to the grade of lieutenant (junior grade): *Provided*, That when the office of chief of bureau is filled by an officer below the rank of rear-admiral, said officer shall, while holding said office, have the rank of rear-admiral and receive the same pay and allowance as are now allowed a brigadier-general in the Army: *And provided further*, That nothing contained in this section shall be construed to prevent the retirement of officers who now have the rank or relative rank of commodore with the rank and pay of that grade: *And provided further*, That all sections of the Revised Statutes which, in defining the rank of officers or positions in the Navy, contain the words "the relative rank of" are hereby amended so as to read "the rank of," but officers whose rank is so defined shall not be entitled, in virtue of their rank to command in the Line or in other Staff Corps. Neither shall this act be construed as changing the titles of officers in the Staff Corps of the Navy. No appointments shall be made of Civil Engineers in the Navy on the active list under Section 413 of the Revised Statutes in excess of the present number, twenty-one.

SEC. 8. That Officers of the Line in the grades of captain, commander and lieutenant-commander may, by official application to the Secretary of the Navy, have their names placed on a list which shall be known as the list of "Applicants for voluntary retirement," and when at the end of any fiscal year the average vacancies for the fiscal years subsequent to the passage of this act above the grade of commander have been less than thirteen, above the grade of lieutenant-commander less than twenty, above the grade of lieutenant less than twenty-nine, and above the grade of lieutenant (junior grade) less than forty, the President may, in the order of the rank of the applicants, place a sufficient number on the retired list with the rank and three-fourths the sea pay of the next higher grade, as now existing, including the grade of commodore, to cause the aforesaid vacancies for the fiscal year then being considered.

SEC. 9. That should it be found at the end of any fiscal year that the retirements pursuant to the provisions of law now in force, the voluntary retirements provided for in this act, and casualties are not sufficient to cause the average vacancies enumerated in Section 8 of this act, the Secretary of the Navy shall, on or about the 1st day of June, convene a Board of five rear-admirals, and shall place at its disposal the service and medical records on file in the Navy Department of all the officers in the grades of captain, commander, lieutenant-commander and lieutenant. The Board shall then select, as soon as practicable after July 1, a sufficient number of officers from the before mentioned grades, as constituted on June 30 of that year, to cause the average vacancies enumerated in Section 8 of this act. Each member of said Board shall swear, or affirm, that he will, without prejudice or partiality, and having in view solely the special fitness of officers and the efficiency of the naval service, perform the duties imposed upon him by this act. Its finding, which shall be in writing, signed by all the members, not less than four governing, shall be transmitted to the President, who shall thereupon, by order, make the transfers of such officers to the retired list as are selected by the Board: *Provided*, That not more than five captains, four commanders, four lieutenant-commanders and two lieutenants are so retired in any one year. The promotions to fill the vacancies thus created shall date from the 30th day of June of the current year: *And provided further*, That any officer retired under the provisions of this section shall be retired with the rank and three-fourths the sea pay of the next higher grade, including the grade of commodore, which is retained on the retired list for this purpose.

SEC. 10. That of the naval constructors five shall have the rank of captain, five of commander, and all others that of lieutenant-commander or lieutenant. Assistant naval constructors shall have the the rank of lieutenant or lieutenant (junior grade). Asistant naval constructors shall be promoted to the grade of naval constructor after not less than eight or more than fourteen years' service as assistant naval constructor: *Provided*, That the whole number of naval constructors and assistant naval constructors on the active list shall not exceed forty in all.

SEC. 11. That any officer of the Navy, with a creditable record, who served during the Cival War, shall, when retired, be retired with the rank and three-fourths the sea pay of the next higher grade.

Previous to the passage of the bill the active list of the Line and Engineer Corps, in all grades, was limited by law to 726 and 196 officers respectively, or, in all 922. An increase to 1,020 is provided for in the new organization to meet the requirements of an increased matériel. Any future enlargement of the *personnel*, should it be necessary by reason of the seemingly sound policy of adding ships year by year to the Navy, can readily be adjusted by a percentage increase of the numbers established for each grade by the bill. This course is advocated by Rear Admiral Crowninshield, Chief of the Bureau of Navigation, in his annual report for 1898, who states that these numbers received the very careful consideration of the Board, and were fixed according to the needs of the service at the time the bill was framed, in 1897.

The clause granting actual instead of relative rank to Staff Officers will unquestionably remove a source of discontent which has been a serious menace to the efficiency of the Navy. While authority is expressly denied to command outside of the corps to which a

Staff Officer belongs, he is nevertheless empowered to exercise military prerogatives, under certain circumstances, in his own corps. This follows very closely the custom of the Army, which has always given entire satisfaction.

In abolishing the grade of Commodore, except for retirement purposes, the universal custom of the rest of the world is followed in making the lowest flag rank that of Rear Admiral.

Sections 8 and 9, which aim to cause an even flow of promotion during an officer's active career, are of vital importance to the efficiency of the Navy. Heretofore this matter has been left entirely to chance, the United States being the only service worthy of the name in which such a faulty system prevailed. In consequence of this, there have been in the past periods of congestion and stagnation, followed by rapid advancement, with a regular recurrence of these conditions. Foreign navies long ago recognized the evils of a system based purely on seniority promotion, and various expedients are in vogue to correct this defect. All, however, reach the same end by slightly different methods.

Provision for the commissioning of Warrant Officers is contained in the following section:

SEC. 12. That boatswains, gunners, carpenters and sailmakers shall after ten years from date of warrant be commissioned chief boatswains, chief gunners, chief carpenters and chief sailmakers, to rank with but after ensign: *Provided*, That the chief boatswains, chief gunners, chief carpenters and chief sailmakers shall on promotion have the same pay and allowances as are now allowed a second lieutenant in the Marine Corps: *Provided*, That the pay of boatswains, gunners, carpenters and sailmakers shall be the same as that now allowed by law: *Provided further*, That nothing in this act shall give additioal rights to quarters on board ship or to command, and that immediately after the passage of this act boatswains, gunners, carpenters and sailmakers, who have served in the Navy as such for fifteen years, shall be commissioned in accordance with the provisions of this section, and thereafter no Warrant Officer shall be promoted until he shall have passed an examination before a Board of chief boatswains, chief gunners, chief carpenters and chief sailmakers, in accordance with regulations prescribed by the Secretary of the Navy.

Warrant Officers are now invariably recruited from the enlisted force, being subjected to a rigid mental and physical examination previous to appointment. This provision allows advancement to the grade of ensign, and is the only means by which an enlisted man can gain a commission.

The bill makes a radical change in the compensation allowed the sea-going corps:

SEC. 13. That, after June 30, 1899, commissioned Officers of the Line of the Navy and of the Medical and Pay Corps shall receive the same pay and allowances, except forage, as are or may be provided by or in pursuance of law for the officers of corresponding rank in the Army: *Provided*, That such officers when on shore shall receive the allowances, but fifteen per cent less pay than when on sea duty; but this provision shall not apply to Warrant Officers commissioned under Section 12 of this act: *Provided further*, That when naval officers are detailed for shore duty beyond seas they shall receive the same pay and allowances as are or may be provided by or in pursuance of law for officers of the Army detailed for duty in similar places: *Provided further*, That naval chaplains, who do not possess relative rank, shall have the rank of lieutenant in the Navy; and that all officers, including Warrant Officers, who have been or may be appointed to the Navy from civil life shall, on the date of appointment, be credited, for computing their pay, with five years' service. And all provisions of law authorizing the distribution among captors of the whole or any portion of the proceeds of vessels, or any property hereafter captured, condemned as prize, or providing for the payment of bounty for the sinking or destruction of vessels of the enemy hereafter occurring in time of war, are hereby repealed: *And provided further*, That no provision of this act shall operate to reduce the present pay of any commissioned officer now in the Navy; and in any case in which the pay of such an officer would otherwise be reduced he shall continue to receive pay according to existing law: *And provided further*, That nothing in this act shall operate to increase or reduce the pay of any officer now on the retired list of the Navy.

The present Pay Table of the Navy was framed in 1871, and while, no doubt, it was fair and equitable for the conditions which then existed, so great has been the change in late years that it now presents many incongruities. It seems plain that the Table was not founded on any rational plan, as each of the different corps received pay on quite a different basis. As an easy solution of an intricate problem, the comprehensive Army Pay Table is substituted, which takes into account not only the rank held by an officer, but in addition, the number of years of active service.

In order to increase the efficiency of the skilled mechanics and offer some reward for faithfulness and zeal, a new Warrant grade is created—that of Warrant Machinist. It is believed the inducement thus held out will cause the most capable of the mechanical force to remain in the service, which at present is not the case. The pay of Warrant Machinists is $1,200 per annum at entry, increasing gradually, with length of service, up to $1,800, after twelve years from date of appointment.

SEC. 14. That upon the passage of this act the Secretary of the Navy shall appoint a Board for the examination of men for the position of Warrant Machinists, 100 of whom are hereby authorized. The said examination shall be open, first, to all machinists by trade, of good record in the naval service, and if a sufficient number of machinists from the Navy are not found duly qualified, then any machinist of good character, not above thirty years of age, in civil life shall be eligible for such examination and appointment to fill the remaining vacancies. All subsequent vacancies in the list of Warrant Machinists shall be filled by competitive examination before a Board ordered by the Secretary of the Navy, and open to all machinists by trade who are in the Navy, and machinists of good character, not above thirty years of age, in civil life authorized by the Secretary of the Navy to appear before said Board, and, where candidates from civil life and from the naval service possess equal qualifications, the preference shall be given to those from the naval service.

SEC. 15. That the pay of Warrant Machinists shall be the same as that of Warrant Officers, and they shall be retired under the provisions of existing law for Warrant Officers. Warrant Machinists shall receive at first an acting appointment, which may be made permanent under regulations established by the Navy Department for other Warrant Officers. They shall take rank with other Warrant Officers according to date of appointment and shall wear such uniform as may be prescribed by the Navy Department.

The succeeding two sections provide for an enlistment period of four years and establish a retired list for deserving enlisted men:

SEC. 16. That hereafter the term of enlistment of all enlisted men of the Navy shall be four years: *Provided*, That Section 1573, Revised Statutes, be amended to read: "If any enlisted man or apprentice, being honorably discharged, shall re-enlist for four years within four months thereafter, he shall, on presenting his honorable discharge or on accounting in a satisfactory manner for its loss, be entitled to pay during the said four months equal to that to which he would have been entitled if he had been employed in actual service; and that any man who has received an honorable discharge from his last term of enlistment, or who has received a recommendation for re-enlist-

ment upon the expiration of his last term of service of not less than three years, who re-enlists for a term of four years within four months from the date of his discharge, shall receive an increase of one dollar and thirty-six cents per month to the pay prescribed for the rating in which he serves for each consecutive re-enlistment."

SEC. 17. That when an enlisted man or appointed petty officer has served as such thirty years in the United States Navy, either as an enlisted man or petty officer, or both, he shall, by making application to the President, be placed on the retired list hereby created, with the rank held by him at the date of retirement; and he shall thereafter receive 75 per centum of the pay and allowances of the rank or rating upon which he was retired: *Provided*, That if said enlisted man or appointed petty officer had active service in the Navy or in the Army or Marine Corps, either as volunteer or regular, during the Civil or Spanish-American war, such war service shall be computed as double time in computing the thirty years necessary to entitle him to be retired: *And provided further*, That applicants for retirement under this section shall, unless physically disqualified for service, be at least fifty years of age.

A radical reorganization of the Marine Corps is covered in the remaining sections of the bill. The enlisted strength of the corps is increased from 3,073 to 6,000, with a corresponding increase in the officers:

SEC. 18. That from and after the date of the approval of this act the active list of the Line Officers of the United States Marine Corps shall consist of one brigadier-general commandant, five colonels, five lieutenant colonels, ten majors, sixty captains, sixty first lietenants and sixty second lieutenants: *Provided*, That vacancies in all grades in the Line created by this section shall be filled as far as possible by promotion by seniority from the Line Officers on the active list of said corps: *And provided further*, That the commissions of officers now in the Marine Corps shall not be vacated by this act: *And provided further*, That vacancies in the grade of brigadier-general shall be filled by selection from officers on the active list of the Marine Corps not below the grade of field officer.

SEC. 19. That the vacancies existing in said corps after the promotions and appointments herein provided for shall be filled by the President from time to time, whenever the actual needs of the naval service require it, first from the graduates of the Naval Academy in the manner now provided by law; or second, from those who are serving or who have served as second lieutenants in the Marine Corps during the war with Spain; or, third, from meritorious non-commissioned officers of the Marine Corps; or, fourth, from civil life: *Provided*, That after said vacancies are once filled there shall be no further appointments from civil life.

SEC. 20. That no person except such officers or former graduates of the Naval Academy as have served in the war with Spain, as hereinbefore provided for, shall be appointed a commissioned officer in the Marine Corps who is under twenty or over thirty years of age; and that no person shall be appointed a commissioned officer in said corps until he shall have passed such examination as may be prescribed by the President of the United States, except graduates of the Naval Academy, as above provided. That the officers of the Marine Corps above the grade of captain, except brigadier-general, shall, before being promoted, be subject to such physical, mental and moral examination as is now, or may hereafter be, prescribed by law for other officers of the Marine Corps.

SEC. 21. That upon the passage of this act not more than forty-five of the captains, forty-five first lieutenants and forty-five second lieutenants herein provided for shall be appointed: fifteen captains, fifteen first lieutenants and fifteen scond lieutenants to be appointed subsequently to January 1, 1900.

SEC. 22. That the staff of the Marine Corps shall consist of one adjutant and inspector, one quartermaster and one paymaster, each with the rank of colonel; one assistant adjutant and inspector, two assistant quartermasters and one assistant paymaster, each with the rank of major; and three asistant quartermasters, with the rank of captain. That the vacancies created by this act in the departments of the adjutant and inspector and paymaster shall be filled first by promotion, according to seniority of the officers in each of these departments, respectively, and then by selection from the Line Officrs on the active list of the Marine Corps not below the grade of captain, and who shall have seen not less than ten years' service in the Marine Corps. That the vacancies created by this act in the quartermaster's department of said corps shall be filled, first by promotion according to seniority of the officers in this Department, and then by selection from the Line Officers on the active list of said corps not below the grade of first lieutenant: *Provided*, That all vacancies hereafter occurring in the staff of the Marine Corps shall be filled first by promotion, according to seniority of the officers in their respective departments, and then by selection from Officers of the Line on the active list, as hereinbefore provided for.

SEC. 23. That the enlisted force of the Marine Corps shall consist of 5 sergeant majors, 1 drum major, 20 quartermaster sergeants, 72 gunnery sergeants, with the rank and allowance of the first sergeant, and whose pay shall be thirty-five dollars per month; 60 first sergeants; 240 sergeants; 480 corporals; 80 drummers; 80 trumpeters, and 4,962 privates.

SEC. 24. That the band of the United States Marine Corps shall consist of one leader, with the pay and allowances of a first lieutenant; one second leader, whose pay shall be seventy-five dollars per month, and who shall have the allowances of a sergeant major; thirty first-class musicians, whose pay shall be sixty dollars per month; and thirty second-class musicians, whose pay shall be fifty dollars per month and the allowances of a sergeant; such musicians of the band to have no increased pay for length of service.

SEC. 25. That the oath of allegiance now provided for the officers and men of the Army and Marine Corps shall be administered hereafter to the officers and men of the Navy.

The bill concludes with the usual clause that all acts and parts of acts, in so far as they conflict with the provisions of the present act, are repealed.

AMENDMENTS TO THE U. S. STEAMBOAT RULES AND REGULATIONS FOR 1899.

At the recent meeting of the Board of Supervising Inspectors, held in Washington, D. C., with Supervising Inspector General James A. Dumont in the chair, amendments were made to the existing steamboat rules and regulations. Following is the text of the rules amended in part only, the parts stricken out being inclosed in brackets [thus], while the additions to such paragraphs are printed in *italics*. Entirely new sections and paragraphs of sections are set in plain type, preceded by the word (new) in parentheses.

RULES.

Rule I.

SECTION 4. (New paragraph at end of section.)

The diameter of rivets, rivet holes, distance between centers of rivets and distance from centers of rivets to edge of lap for different thicknesses of plates for single and double riveting shall be determined by the rules of the British Board of Trade. This rule shall take effect on July 1, 1899. (See Appendix.)

Rule II.

SECTION 2. (Second paragraph.)

All boilers built for marine purposes [after July 1, 1898,] shall be required to have [all] *the rivet holes in the shell, heads, steam and mud drums, and all other parts of the boiler, (excepting for longitudinal and circumferential seams in flues for same 20 inches outside diameter and under)*, fairly drilled instead of punched. [: and, the longitudinal laps of their cylindrical parts double-riveted, to be entitled to 20 per cent additional pressure.]

Boilers, to be entitled to the 20 per cent additional pressure allowed by law, must have the longitudinal laps of their cylindrical parts double-riveted.

SECTION 14. (New, to precede first paragraph.)

14. Corrugated furnace flues constructed with corrugations eight inches from center to center, the radius of outer corrugation being not more than one-half of the reverse or suspension curve, the plain parts at the ends not exceeding nine inches in length, made of plates not less than five-sixteenths of an inch thick, when new, corrugated with practically true circles, shall be allowed a steam pressure in accordance with the following formula:

$$\text{Pressure in pounds} = \frac{15000}{D} \times T,$$

where T = thickness, in inches;
D = mean diameter, in inches.

EXAMPLE.

Given a corrugated flue as above, 40 inches in diameter, $\frac{5}{16}$ inch thick; required, the pressure of steam allowable.

$$\frac{15000}{40} \times \frac{5}{16} = 117.18 \text{ pounds.}$$

(First paragraph, first line.)

The strength of all corrugated flues, *other than described in the preceding paragraph of this section*, * * * .

SECTION 15. (First two paragraphs amended and transposed from page 30 to follow the examples on page 33, Rules and Regulations.)

15. The steam pressure allowable and the thickness of material required for flues used as furnaces in *vertical* boilers, [and for vertical boiler] *such* furnace [s] *flues* having a diameter of not more than 42 inches and a [height] *length* of not more than 40 inches, except as hereafter otherwise provided, shall be determined by the following formula, viz.:

$$P = \frac{89600 \times T^2}{L \times D},$$

where P = pressure of steam allowable, in pounds;
T = thickness of flue, in decimals of an inch;
L = length of flue, in feet [not to exceed 8 feet];
D = diameter of flue, in inches.

EXAMPLE.

(New, in lieu of old.)

Given a vertical furnace flue $3\frac{1}{3}$ feet in length, 42 inches in diameter, and .5 inch thick; required, the pressure allowable by the inspectors.

Substituting the values in the formula, and performing the operation indicated, the pressure allowable,

$$P = \frac{89600 \times .25}{3\frac{1}{3} \times 42} = 160 \text{ pounds.}$$

SECTION 15. (Third paragraph.)

[Provided, That when such] *When plain horizontal* flues are made in sections * * * the distance between the flanges, or the distance between such angle-iron rings, shall be taken as the length of the flue in determining the pressure allowable, *which pressure shall be determined in accordance with the following formula:*

$$P = \frac{89600 \times T^2}{L \times D},$$

where P = pressure of steam allowable, in pounds;
T = thickness of flue, in decimals of an inch;
L = length of section, in feet;
D = diameter of flue, in inches.

SECTION 15. (New, added to section.)

Formula for crown bars over back connection and furnaces.

$$\text{Working pressure} = \frac{C \times d^2 \times T}{(W - P) \times D \times L},$$

where W = width of combustion box, in inches;
P = pitch of supporting bolts, in inches;
D = distance between girders from center to center, in inches;
L = length of girder, in feet;
d = depth of girder, in inches;
T = thickness of girder, in inches;
C = 550 when the girder is fitted with one supporting bolt;
C = 825 when the girder is fitted with two or three supporting bolts;
C = 935 when the girder is fitted with four supporting bolts.

EXAMPLE.

Given W = 34 inches, P = 7.5 inches, D = 7.75 inches, L = 2.927 feet, d = 7.5 inches, T = 2 inches, C = 825, then, substituting in formula,

$$\text{Working pressure} = \frac{825 \times 7.5^2 \times 2}{(34 - 7.5) \times 7.75 \times 2.927} =$$

154.3 pounds.

SECTION 21. (Second paragraph.)

All manholes for the shell of boilers over 40 inches in diameter, *where practicable for use*, shall have an opening not less than 11 by 15 inches in the clear, except * * * .

SECTION 38. (Second paragraph, page 41.)

The terminal and intermediate joints of all wrought-iron and homogeneous steel feed and steam pipes over [2] *3* inches in diameter [and not over 5 inches in diameter], other than on pipe or coil boilers or steam generators, shall be made of wrought iron, homogeneous steel or [malleable iron] flanges [or] *of* equivalent material; * * * .

SECTION 38. (Third paragraph, page 41.)

But where such pipes are made of extra heavy lap-welded steam pipe, *up to and including 5 inches*, the flanges may be attached with screw threads; and all joints in bends may be made with good and substantial malleable-iron elbows or equivalent material.

SECTION 38. (Last paragraph, page 41.)

All lap-welded iron or steel steam pipes over 5 inches in diameter or riveted wrought-iron or steel steam pipes over 5 inches in diameter, in addition to being expanded into tapered holes, and substantially beaded into recess in face of flanges [as provided in preceding paragraph for steam and feed pipes exceeding 2 inches and not exceeding 5 inches in diameter], shall be substantially and firmly riveted with good and substantial rivets through the hubs of such flanges; and no such hubs shall project from such flanges less than 2 inches in any case.

SECTION 38. (Second paragraph, page 42.)

When holes exceeding 6 inches in diameter are cut in boilers for pipe connections, man and hand hole plates, such holes shall be reinforced, either on the inside or outside of boiler, with reinforcing plates, which shall be securely riveted to the boiler, *in flat surfaces; and, where such opening is made in the circumferential plates of such boilers, the reinforcing ring shall have a sectional area of at least one-half the area of material there would be in a line drawn across such opening parallel with the longitudinal seams of such portion of the boiler;* * * * .

SECTION 40. (New.)

40. No cast-iron nozzles, branch pipes, or elbows shall be used in connecting steam drums, superheaters, branch pipes, or steam pipes to boilers, and no cast-iron flanges will be allowed to be used on boilers for marine purposes unless such cast iron has been officially tested and test on record in the office of the local inspectors where boiler with such appliances was constructed, and no cast iron with a tensile strength of less than 30,000 pounds will be permitted to be used for such purposes.

Rule V.

SECTION 1. (First paragraph, proviso struck out.)

[Provided, however, That the applicant for renewal is at the time personally within the jurisdiction of the United States inspection laws, as defined in sections 4400 and 4447 of the Revised Statutes.]

(New paragraph inserted after 15th line.)

All licenses hereafter issued to masters, mates, pilots, and engineers shall be filled out on the face with pen and black ink instead of typewritten.

(Transposed from section 10, and added to fourth paragraph.)

[Provided, however,] *; and*, before granting or renewing a license to pilots, masters, or engineers, inspectors shall satisfy themselves that they can properly hear the bell and whistle signals.

SECTION 7.

7. Second-class pilots may be allowed to take charge of steamers not exceeding 100 tons burden, may be authorized by the license granted to act in charge of a watch as assistant to a first-class pilot on *passenger*, freight, and towing steamers of all tonnage.

(Paragraph transposed from section 11, Rule V.)

On the Northwestern Lakes and connecting waters, any person holding a second-class pilot license may come before any local board for examination for first-class pilot license after having served one year as wheelsman, watchman, or as assistant to a first-class pilot on freight, towing, or passenger steamers, such service to have been within two years preceding the application for raise of grade.

SECTION 10. (First paragraph, new.)

10. No original license as master or mate of ocean or coastwise steamers, pilot of steam vessels, or as master or chief mate of sail vessels shall be granted, except on the official certificate of a surgeon of the Marine Hospital Service that the applicant is free from the defect known as color blindness. No renewal of license shall be granted to any officer of the classes named who has not been previously examined and passed for color blindness.

SECTION 10. (Second paragraph, amendment of old third paragraph.)

[In case of original or renewal of any license of any master or pilot who has not been examined] *Any person requring examination* for color blindness, [and] who is living at a distance of 100 miles or more from a surgeon of the Marine Hospital Service, [he] may be examined for color blindness by any respectable physician residing in the same town or locality with said applicant; * * * .

(Old second paragraph transposed to third, and fourth paragraph amended as indicated in section 1, Rule V, herein, by transposition of proviso.)

SECTION 14. (Fourth paragraph, as follows, struck out. See section 10, Rule V, herein.)

[And that hereafter no original master or chief mate of ocean or coastwise steamers shall be granted a license without first having been examined and passed for color blindness.]

SECTION 15.

15. * * * And it shall be the duty of such master, or of the mate or officer next in command, once at least in each week, to call all hands to quarters and exercise them in the discipline, *and in the unlashing and swinging out of the lifeboats, weather permitting, and in the* use of the fire pumps and all other apparatus for the safety of life on board of such vessel, * * * .

SECTION 26. (New.)

Local inspectors may, upon due application, license as masters and chief mates of sail vessels of over 700 tons, upon receipt of satisfactory documentary evidence, to be filed in their office, that said masters or mates have been actually employed as such officers on vessels of the tonnage named, for the full period of twelve months preceding the application for license, provided such officers shall be found upon examination to be free from color blindness.

Applicants for master's or mate's license on sail vessels, who have had no previous service as either master or mate, except on rivers and on the Great Lakes, must be duly examined in navigation the same as required for masters and mates of steam vessels, such examinations to be in writing; and the applicants must be free from color blindness:

Provided, That no master, except as provided in the first paragraph of this section, shall be licensed who has not served a full term of one year on such sail vessels as chief mate, nor shall any person be eligible to be examined as chief mate of sail vessel, unless he can furnish satisfactory documentary evidence that he had at least three full years' experience on sail vessels of three hundred gross tons and upward.

Rule IX.

SECTION 8. (Third paragraph.)

All steam whistles shall be placed not less than 6 feet above the top of the pilot house of steam vessels where the height of smokestack will admit the attachment of same below its top, when not hinged for passing under bridges, *except upon steamers navigating the Red River of the North and rivers whose waters flow into the Gulf of Mexico, and steamers of less than*

one hundred gross tons, whose steam whistles shall be placed not less than two feet above the tops of their pilot houses; and it shall be the duty of inspectors to enforce this rule at the annual inspection.

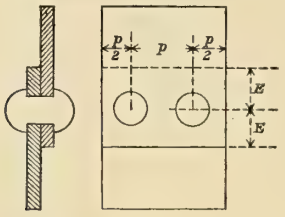
Rule X.

SECTION 8. (Repealed.)

[8. All steam vessels (except upon the Red River of the North and rivers whose waters flow into the Gulf of Mexico), when engaged in towing during fog or thick weather, shall sound three distinct blasts of their steam whistles in quick succession, repeating at intervals not exceeding one minute.]

IRON PLATES AND IRON RIVETS

SINGLE-RIVETED LAP JOINTS.



Thickness of plates.	Diameter of rivets.	Pitch of rivets.	Center of rivets to edge of plates.
T	*d*	*p*	*E*
1/4	5/8	1.524	.937
9/32	31/32	1.600	.984
5/16	1 1/16	1.676	1.031
11/32	1 3/32	1.753	1.078
3/8	3/4	1.829	1.125
13/32	1 5/32	1.905	1.171
7/16	1 1/8	1.981	1.218
15/32	1 7/32	2.036	1.265
1/2	7/8	2.077	1.312
17/32	1 9/32	2.120	1.359
9/16	1 1/8	2.164	1.406
19/32	1 11/32	2.210	1.453
5/8	1	2.256	1.500
21/32	1 1/32	2.304	1.546
11/16	1 1/16	2.352	1.593
23/32	1 3/32	2.400	1.640
3/4	1 1/8	2.450	1.687
25/32	1 5/32	2.500	1.734
13/16	1 3/16	2.550	1.781
27/32	1 7/32	2.601	1.828
7/8	1 1/4	2.652	1.875
29/32	1 9/32	2.703	1.921
15/16	1 5/16	2.755	1.968

Rules of Practice.

SECTION 6.

At any time before the conclusion of the evidence the charge or charges, *if being tried on charges*, may be amended, notice of said amendment being furnished to the accused of the nature of such amendment, but no amendment shall be permitted after the conclusion of the evidence.

Pilot Rules, Atlantic and Pacific Coast Inland Waters.

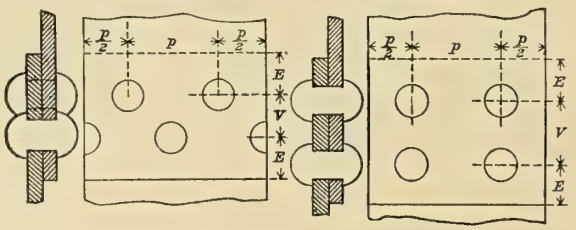
RULE III [(Act of June 7, 1897)]. If, when steam vessels are approaching each other, either vessel fails to understand the course or intention of the other, from any cause, the vessel so in doubt shall immediately signify the same by giving several short and rapid blasts, not less than four, of the steam whistle; *and, if the vessels shall have approached within half a mile of each other, both shall be immediately slowed to a speed barely sufficient for steerageway until the proper signals are given, answered and understood, or until the vessels shall have passed each other.*

Vessels approaching each other from opposite directions are forbidden to use what has become technically known among pilots as "cross signals"—that is, answering one whistle with two, and answering two whistles with one. In all cases, and under all circumstances, a pilot receiving either of the whistle signals provided in the rules, which for any reason he deems injudicious to comply with, instead of answering it with a cross signal, must at once observe the provisions of this rule.

IRON PLATES AND IRON RIVETS.

DOUBLE-RIVETED LAP JOINTS.

ZIGZAG RIVETING. CHAIN RIVETING.



Thickness of plates.	Diameter of rivets.	Pitch of rivets.	Center of rivets to edge of plates.	Distance between rows of rivets.	
				Zigzag riveting.	Chain riveting.
T	*d*	*p*	*E*	*V*	*V*
5/16	5/8	2.272	.937	1.145	1.750
13/32	31/32	2.386	.984	1.202	1.812
3/8	1 1/16	2.500	1.031	1.260	1.875
15/32	1 3/32	2.613	1.078	1.317	1.937
7/16	3/4	2.727	1.125	1.374	2.000
17/32	1 5/32	2.826	1.171	1.426	2.062
1/2	1 7/32	2.886	1.218	1.465	2.125
17/32	1 9/32	2.948	1.265	1.504	2.187
9/16	7/8	3.013	1.312	1.544	2.250
19/32	1 11/32	3.079	1.359	1.585	2.312
5/8	1 1/8	3.146	1.406	1.626	2.375
21/32	1 11/32	3.215	1.453	1.667	2.437
11/16	1	3.284	1.500	1.709	2.500
23/32	1 1/32	3.355	1.546	1.751	2.562
3/4	1 1/16	3.426	1.593	1.794	2.625
25/32	1 3/32	3.498	1.640	1.836	2.687
13/16	1 1/8	3.571	1.687	1.879	2.750
27/32	1 5/32	3.645	1.734	1.923	2.812
7/8	1 3/16	3.718	1.781	1.966	2.875
29/32	1 7/32	3.793	1.828	2.009	2.937
15/16	1 1/4	3.867	1.875	2.053	3.000
31/32	1 9/32	3.942	1.921	2.096	3.062
1	1 5/16	4.018	1.968	2.140	3.125

Lights for Boom Rafts.

(Amendment to resolution of Board of Supervising Inspectors, contained in Pilot Rules for Western Rivers, page 10, Form 2103¼; and page 15, Form 2102½.)

Resolved, * * * Boom rafts with cross binders towed ahead of steamers on the Mississippi and Ohio Rivers, and other waters flowing into the Gulf of Mexico, and on the Red River of the North, shall carry a white light [twelve] *four* feet high at the forward end of the raft, and one such light at each side midway between the forward and after end. * * *

APPENDIX.

The following formulas, equivalent to those of the

British Board of Trade, are given for the determination of the pitch, distance between rows of rivets, diagonal pitch, maximum pitch, and distance from centers of rivets to edge of lap of single and double riveted lap joints, for both iron and steel boilers:

Let p = greatest pitch of rivets, in inches;
n = number of rivets, in one pitch;
p_d = diagonal pitch, in inches;
d = diameter of rivets, in inches;
T = thickness of plate, in inches;
V = distance between rows of rivets, in inches;
E = distance from edge of plate to center of rivet, in inches.

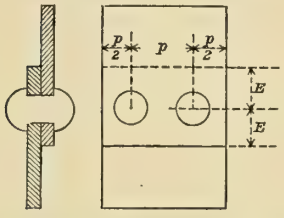
TO DETERMINE THE PITCH.

Iron plates and iron rivets:

$$p = \frac{d^2 \times .7854 \times n}{T} + d.$$

STEEL PLATES AND STEEL RIVETS.

SINGLE-RIVETED LAP JOINTS.



Thickness of plates.	Diameter of rivets.	Pitch of rivets.	Center of rivets to edge of plates.
T	d	p	E
$\frac{1}{4}$	$\frac{11}{16}$	1.562	1.031
$\frac{9}{32}$	$\frac{23}{32}$	1.633	1.078
$\frac{5}{16}$	$\frac{3}{4}$	1.704	1.125
$\frac{11}{32}$	$\frac{25}{32}$	1.775	1.171
$\frac{3}{8}$	$\frac{13}{16}$	1.846	1.218
$\frac{13}{32}$	$\frac{27}{32}$	1.917	1.265
$\frac{7}{16}$	$\frac{7}{8}$	1.988	1.312
$\frac{15}{32}$	$\frac{29}{32}$	2.036	1.359
$\frac{1}{2}$	$\frac{15}{16}$	2.071	1.406
$\frac{17}{32}$	$\frac{31}{32}$	2.108	1.453
$\frac{9}{16}$	1	2.146	1.500
$\frac{19}{32}$	$1\frac{1}{32}$	2.186	1.546
$\frac{5}{8}$	$1\frac{1}{16}$	2.227	1.593
$\frac{21}{32}$	$1\frac{3}{32}$	2.269	1.640
$\frac{11}{16}$	$1\frac{1}{8}$	2.312	1.687
$\frac{23}{32}$	$1\frac{5}{32}$	2.356	1.734
$\frac{3}{4}$	$1\frac{3}{16}$	2.400	1.781
$\frac{25}{32}$	$1\frac{7}{32}$	2.445	1.828
$\frac{13}{16}$	$1\frac{1}{4}$	2.500	1.875
$\frac{27}{32}$	$1\frac{9}{32}$	2.562	1.921
$\frac{7}{8}$	$1\frac{5}{16}$	2.625	1.968
$\frac{29}{32}$	$1\frac{11}{32}$	2.687	2.015
$\frac{15}{16}$	$1\frac{3}{8}$	2.750	2.062

Example: First, for single-riveted joint—

Given, thickness of plate (T) = ½ inch, diameter of rivet (d) = ⅞ inch. In this case, $n = 1$. Required, the pitch.

Substituting in formula, and performing operation indicated,

$$\text{Pitch} = \frac{(\frac{7}{8})^2 \times .7854 \times 1}{\frac{1}{2}} + \frac{7}{8} = 2.077 \text{ inches.}$$

For double-riveted joint—

Given, $t = \frac{1}{2}$ inch, and $d = \frac{13}{16}$ inch. In this case, $n = 2$. Then—

$$\text{Pitch} = \frac{(\frac{13}{16})^2 \times .7854 \times 2}{\frac{1}{2}} + \frac{13}{16} = 2.886 \text{ inches.}$$

For *steel* plates and steel rivets:

$$p = \frac{23 \times d^2 \times n}{28 \times T} + d.$$

Example, for single-riveted joint: Given, thickness of plate = ½ inch, diameter of rivet = $\frac{15}{16}$ inch. In this case, $n = 1$.

$$\text{Pitch} = \frac{23 \times (\frac{15}{16})^2 \times .7854 \times 1}{28 \times \frac{1}{2}} + \frac{15}{16} = 2.071 \text{ inches.}$$

Example, for double-riveted joint: Given, thickness of plate = ½ inch, diameter of rivet = ⅞ inch. $n = 2$. Then—

$$\text{Pitch} = \frac{23 \times (\frac{7}{8})^2 \times .7854 \times 2}{28 \times \frac{1}{2}} + \frac{7}{8} = 2.85 \text{ inches.}$$

FOR DISTANCE FROM CENTER OF RIVET TO EDGE OF LAP.

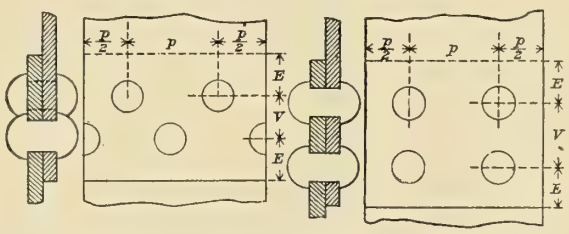
$$E = \frac{3 \times d}{2}.$$

Example: Given, diameter of rivet (d) = ⅞ inch; required, the distance from center of rivet to edge of plate.

STEEL PLATES AND STEEL RIVETS.

DOUBLE-RIVETED LAP JOINTS.

ZIGZAG RIVETING. CHAIN RIVETING.



Thickness of plates.	Diameter of rivets.	Pitch of rivets.	Center of rivets to edge of plates.	Distance between rows of rivets.	
				Zigzag riveting.	Chain riveting.
T	d	p	E	V	V
$\frac{5}{16}$	$\frac{11}{16}$	2.291	1.031	1.187	1.875
$\frac{11}{32}$	$\frac{23}{32}$	2.395	1.078	1.240	1.937
$\frac{3}{8}$	$\frac{3}{4}$	2.500	1.125	1.295	2.000
$\frac{13}{32}$	$\frac{25}{32}$	2.604	1.171	1.349	2.062
$\frac{7}{16}$	$\frac{13}{16}$	2.708	1.218	1.403	2.125
$\frac{15}{32}$	$\frac{27}{32}$	2.803	1.265	1.453	2.187
$\frac{1}{2}$	$\frac{7}{8}$	2.850	1.312	1.487	2.250
$\frac{17}{32}$	$\frac{29}{32}$	2.900	1.359	1.522	2.312
$\frac{9}{16}$	$\frac{15}{16}$	2.953	1.406	1.558	2.375
$\frac{19}{32}$	$\frac{31}{32}$	3.008	1.453	1.595	2.437
$\frac{5}{8}$	1	3.064	1.500	1.631	2.500
$\frac{21}{32}$	$1\frac{1}{32}$	3.122	1.546	1.669	2.562
$\frac{11}{16}$	$1\frac{1}{16}$	3.181	1.593	1.707	2.625
$\frac{23}{32}$	$1\frac{3}{32}$	3.241	1.640	1.745	2.687
$\frac{3}{4}$	$1\frac{1}{8}$	3.302	1.687	1.784	2.750
$\frac{25}{32}$	$1\frac{5}{32}$	3.364	1.734	1.823	2.812
$\frac{13}{16}$	$1\frac{3}{16}$	3.427	1.781	1.863	2.875
$\frac{27}{32}$	$1\frac{7}{32}$	3.490	1.828	1.902	2.937
$\frac{7}{8}$	$1\frac{1}{4}$	3.554	1.875	1.942	3.000
$\frac{29}{32}$	$1\frac{9}{32}$	3.618	1.921	1.981	3.062
$\frac{15}{16}$	$1\frac{5}{16}$	3.683	1.968	2.021	3.125
$\frac{31}{32}$	$1\frac{11}{32}$	3.748	2.015	2.061	3.187
1	$1\frac{3}{8}$	3.814	2.062	2.102	3.250

$$E = \frac{3 \times \frac{7}{8}}{2} = 1.312 \text{ inches,}$$

for single or double riveted lap joint.

FOR DISTANCE BETWEEN ROWS OF RIVETS.

The distance between lines of centers of rows of rivets for double, chain-riveted joints (V) should not

be less than twice the diameter of rivet, but it is more desirable that V should not be less than $\frac{4d+1}{2}$.

Example under latter formula: Given, diameter of rivet = ⅞ inch, then—

$$V = \frac{(4 \times \frac{7}{8}) + 1}{2} = 2.25 \text{ inches.}$$

For ordinary, double, zigzag-riveted joints,

$$V = \frac{\sqrt{(11p + 4d)\ (p + 4d)}}{10}.$$

Example: Given, pitch = 2.85 inches, and diameter of rivet = ⅞ inch, then—

$$V = \frac{\sqrt{(11 \times 2.85 + 4 \times \frac{7}{8})\ (2.85 + 4 \times \frac{7}{8})}}{10} = 1.487 \text{ inches.}$$

DIAGONAL PITCH.

For double, zigzag-riveted lap joint. Iron and steel.

$$p_d = \frac{6p + 4d}{10}.$$

Example: Given, pitch = 2.85 inches, and d = ⅞ inch, then—

$$p_d = \frac{(6 \times 2.85) + (4 \times \frac{7}{8})}{10} = 2.06 \text{ inches.}$$

MAXIMUM PITCHES FOR RIVETED LAP JOINTS.

For single-riveted lap joints, maximum pitch = $(1.31 \times T) + 1\frac{5}{8}$.

For double-riveted lap joints, maximum pitch = $(2.62 \times T) + 1\frac{5}{8}$.

Example: Given a thickness of plate = ½ inch, required, the maximum pitch allowable.

For single-riveted lap joint, maximum pitch = (1.31 × ½) + 1⅝ = 2.28 inches.

For double-riveted lap joint, maximum pitch = (2.62 × ½) + 1⅝ = 2.955 inches.

The tables (pages 30 and 31) taken from the handbook of Thomas W. Traill, entitled "Boilers, Marine and Land, Their Construction and Strength," may be taken for use in single and double riveted joints as approximating the formulas of the British Board of Trade for such joints.

British steel makers and shipbuilders must feel dissatisfied with the new naval shipbuilding programme of the Admiralty. This contemplates the addition of only two battleships, two armored cruisers and three unarmored cruisers, at a total cost of about ten million dollars.

The thirty-ninth meeting of the American Society of Mechanical Engineers will be held in Washington, D. C., commencing May 9. Besides an extensive and interesting professional programme, Secretary F. R. Hutton has provided for the recreation and instruction of members a series of visits and inspections of famous places in the vicinity. Additional interest is lent to this visit from the fact that Rear-Admiral George W. Melville, Engineer-in-Chief of the Navy, is the president of the Society. Among the items on the programme is a reception by President McKinley in the Executive Mansion on the afternoon of May 10. Special arrangements have been made with many of the railroads for a reduced fare for the meeting. The headquarters of the Society during the meeting will be at the Arlington, Vermont avenue and H street N. W., and here a special rate for members of the Society has been secured.

VIBRATIONS OF STEAMSHIPS AND METHODS OF BALANCING MARINE ENGINES—IV.

BY C. H. PEABODY, B. Sc.

Thus far in the discussion of balancing engines but little attention has been given to the irregularity due to the connecting-rod, although attention has been called to the fact that a greater accelerating force is required to start the piston of a vertical marine engine, down from the top of the cylinder, than is required at the lower end. The irregularity becomes more marked as the ratio of the length of the connecting-rod to the crank diminishes. Thus, with a connecting-rod seven times as long as the crank the accelerating force at the lower end is three-fourths as much as that at the upper end, while with a connecting-rod four times as long as the crank, the lower force is only six-tenths of that at the upper end. From this it appears that the methods of balancing proposed by Yarrow and Schlick are really only ways of ameliorating the ill effects felt with unbalanced engines. To show that this is no imaginary evil we may relate an experience with a set of Willans engines at an electric lighting station. The Willans engine is a single acting triple engine, with three pistons on one piston rod. The weight of the reciprocating parts is consequently relatively large, while the connecting-rod is short. These engines are usually arranged in pairs on the same bed, with the cranks opposite, in order to get the same effect as from an ordinary double acting engine. Mr. Robinson and Captain Sankey report that serious trouble was found at the station mentioned when ten such engines, each indicating 200 horse power at 350 revolutions per minute, were mounted on a large slab of concrete, which was 88 ft. long and 24 ft. wide. In the engine room there were no perceptible vibrations, but very unpleasant vibrations were experienced in houses that were 100 ft. distant. The cranks of each of the engines were only 27 in. apart, consequently it did not appear that the vibrations could be due to rocking couples, that is, to the lack of running balance. A calculation of the accelerating forces at the ends of the stroke of the piston of one engine showed that there was a force of 3.54 tons required to start the piston which was at the top of its cylinder, while only 2.31 tons were demanded by the piston at the lower end of the stroke. Consequently there was a net upward pull on the block of concrete equal to 1.23 tons, tending to lift the concrete when the pistons were at the ends of their strokes. A further calculation developed the fact that when the cranks were at 90° with the line of dead points, there was a downward thrust of 1.27 tons on the concrete. With ten engines running at about the same speed it frequently happened that several engines synchronized, and then the pull and push on the concrete set it into oscillations, for it was on a spongy foundation, and the semi-fluid nature of the foundation gave a sort of hydraulic transportation of the oscillations of the concrete slab to the foundations of the houses in the neighborhood.

Again, in both Yarrow's and Schlick's methods of balancing engines it is considered that the side throw of the bob-weight connecting-rods will take care of the unbalanced components of the connecting-rods for

the several pistons. Here again we have an approximate standing balance, but not a running balance, and the side throw of the connecting-rods is likely to set up transverse rocking couples. In this statement it is to be borne in mind that Schlick's method treats some of the pistons as bob-weights for the others. This is, however, more a matter of scientific interest than of practical importance, since the rocking couples can never have an important influence.

Fig. 17 exhibits a very complete balancing of a single cylinder engine by the use of bob-weights on the opposite side of the crank shaft. Both the piston and the bob-weights are shown at the crank end of the stroke, near the crank shaft. It is evident that both

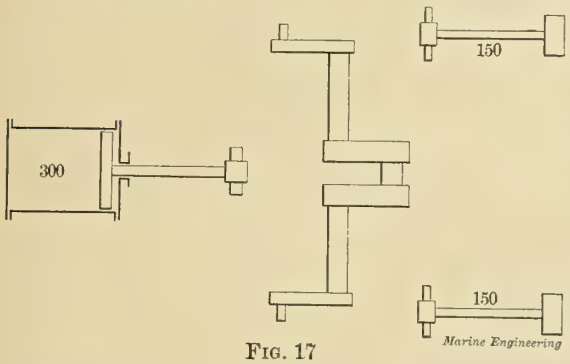


FIG. 17

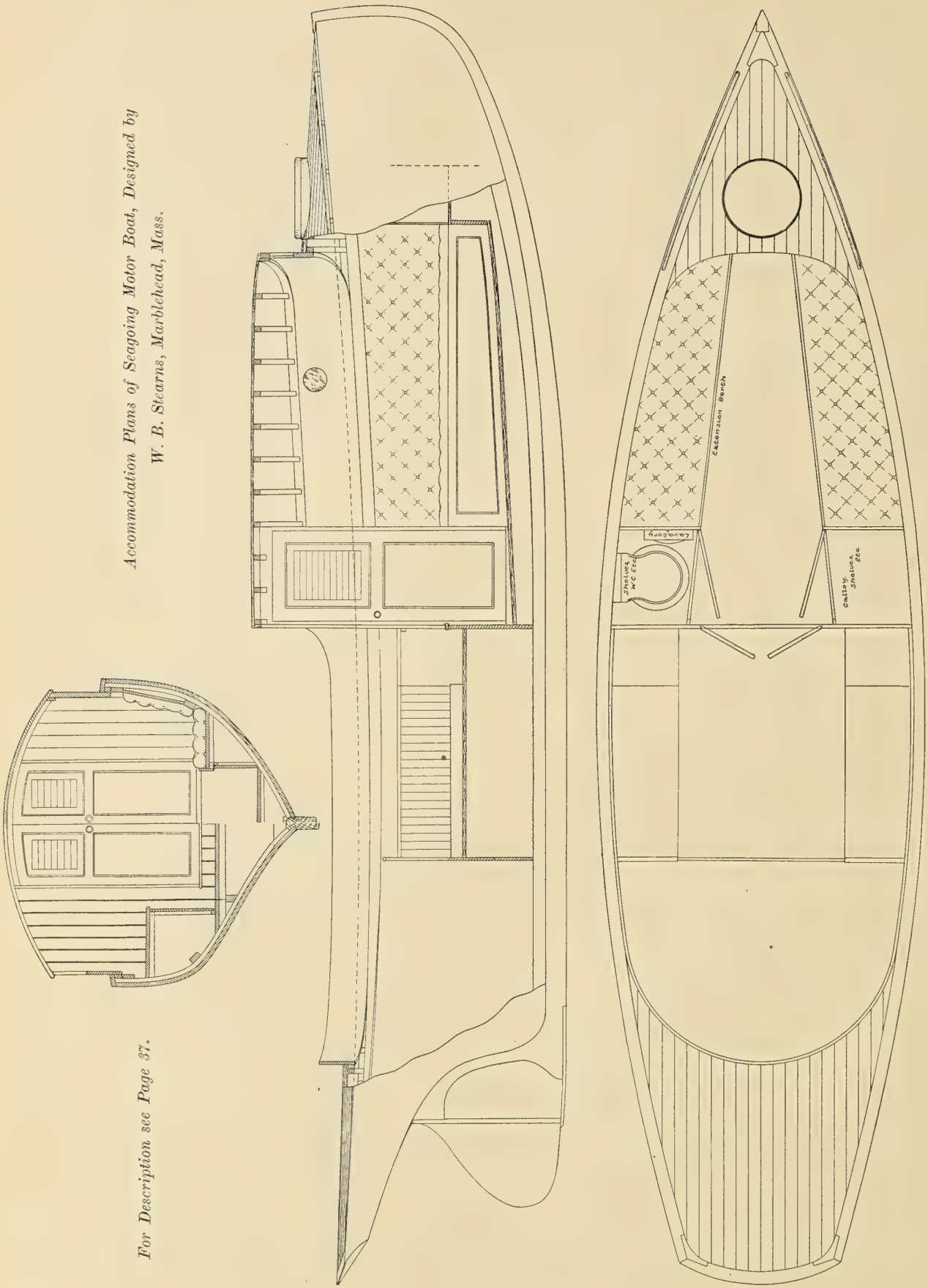
will be at the head-end or the remote end of the stroke at the same instant, and finally that the displacements from one end of the stroke will be exactly equal for all positions. Consequently the center of gravity of the system of piston and bob-weights will remain fixed in position, and there will be no unbalanced longitudinal accelerating forces. The longitudinal accelerating forces acting on the connecting-rods will also be completely balanced, but there will be unbalanced transverse accelerating forces due to the slatting of the connecting-rods. If Fig. 17 represents the plan view of a horizontal engine with bob-weights, the unbalanced transverse forces acting on the connecting-rods will tend to rock the engine bed, throwing it up at one end and down at the other. Of course a three-cylinder engine, simple, compound or triple, can be arranged on this system. A compound engine would naturally have one high-pressure cylinder on one side and two low-pressure cylinders on the other. The reciprocating parts for the high-pressure cylinders would then need to be loaded so as to weigh twice as much as those for one of the low-pressure cylinders. A triple engine might have the high-pressure and intermediate cylinders on one side and the low-pressure cylinder on the other. The distance of the high-pressure and intermediate cylinders from the line of the low-pressure cylinder should be made inversely proportional to the weights of their reciprocating parts. The reciprocating parts for the low-pressure cylinder should, of course, be loaded so as to weigh as much as the reciprocating parts of both the other cylinders. This method of balancing, though very complete, will seldom if ever be used in practice, since everything is sacrificed to the obtaining of one result. The turning effort of the engine is very unsteady, no better than that of a single cylinder engine; the general arrangement is poor, requiring a large extent of piping to lead steam from one cylinder to another; and the weight of the engine bed and of the reciprocating parts will be large. In fact, the arrangement is most interesting as showing that the complete development of one idea may destroy the symmetry and usefulness of a design.

The Willans Engine Company has made engines with six cranks and as many sets of cylinders, three in a set, which have been found to run very steadily. Each set of these cylinders forms a single acting tandem engine, consequently the arrangement with six cranks requires in all eighteen cylinders. The three cranks at one end of the shaft are set at 120°, consequently that half of the engine by itself would be very nearly in standing balance, more nearly so than the ordinary three-cylinder triple engine with three cranks. The other half of the engine also has three cranks set at 120°, and the two halves are joined together so that the cranks come in reverse order, and thus do away with rocking couples. An engine of this sort has been supplied to the Heilman electric locomotive, and drives the electric generator. The driver axles are turned by electric motors, thus involving a double transformation of energy. The leading idea in this locomotive is to avoid the various rolling, pitching and slewing motions of the ordinary steam locomotive, which may be dangerous at very high speeds. It is therefore very important that the engine which drives the electric generator shall not set up vibrations of the locomotive frame on its springs.

Should the application of gas engines to marine propulsion be developed so that they are used on large ships, then the idea just mentioned of so arranging a six crank engine as to avoid setting up vibrations may be of importance to marine engineers.

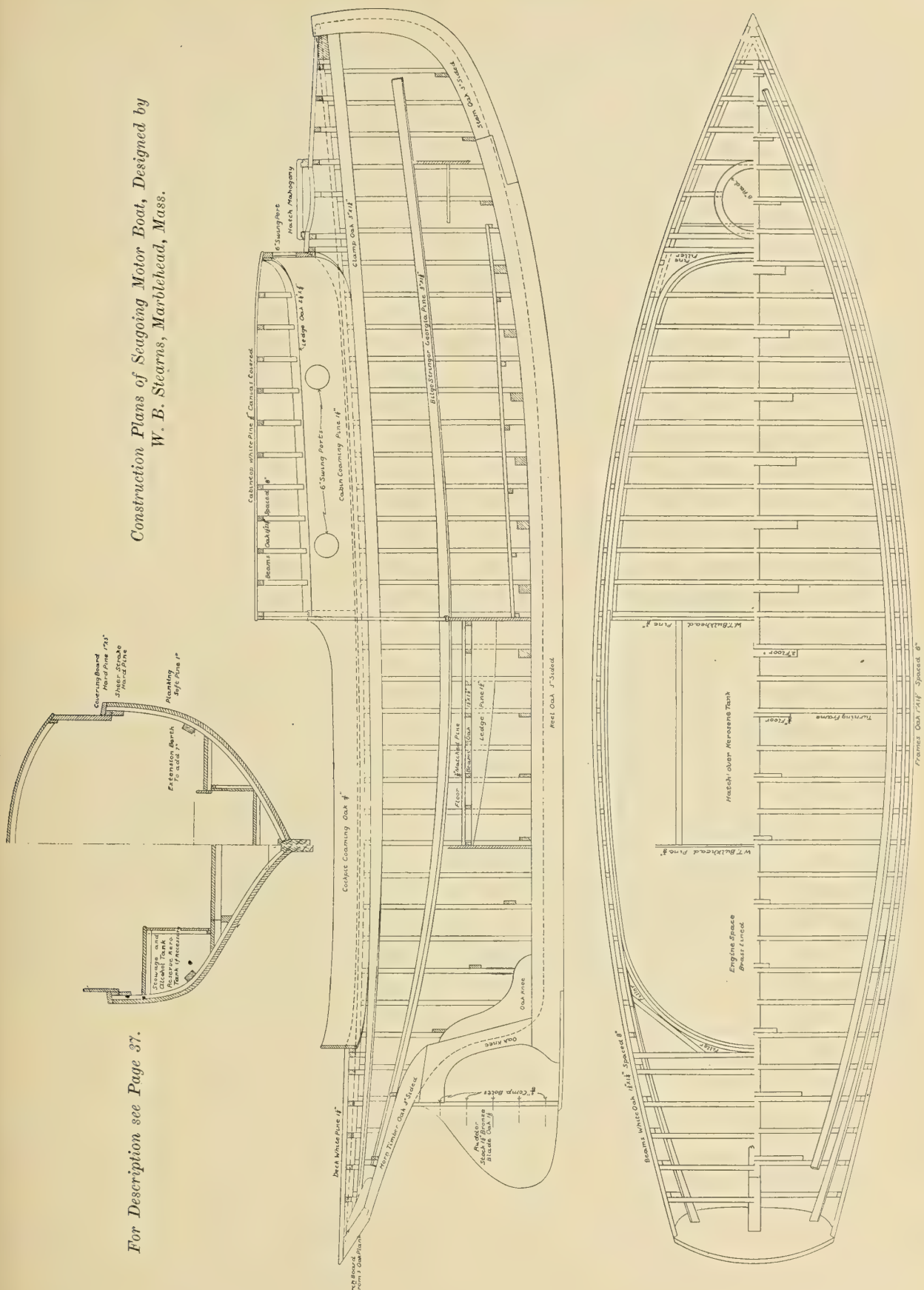
The U. S. Standard Register of Shipping for 1899-1900 has been received. This is the official publication of the United States Steamship Owners', Builders' and Underwriters' Association, Ltd., and is familiarly known as the Red Book. It is a very complete record of the scope and work of the society. It opens by a tariff of the classification fees. The rules for the construction and classification of steel and composite vessels are very completely set out and are extensively illustrated by well printed plates. Wooden vessels intended for service on the Great Lakes are also represented by various plans and sections. The list of vessels in the Register covers about 100 pages, and is followed by many pages in blank, alphabetically arranged, in which the additions made during the year can be inserted. There are many subsidiary matters in the book, such as the rules for the use of electric light on shipboard, etc. Altogether the volume is very complete and exceedingly useful for reference. The annual subscription is $10.00, and this may be forwarded to the office of the Association, in the Post Building, 16 and 18 Exchange place, New York, or to the surveyors who are stationed at New York, Newport, R. I., Baltimore, Boston, Victoria, B. C., Buffalo, N. Y., Chicago and at Liverpool, England.

Accommodation Plans of Seagoing Motor Boat, Designed by W. B. Stearns, Marblehead, Mass.

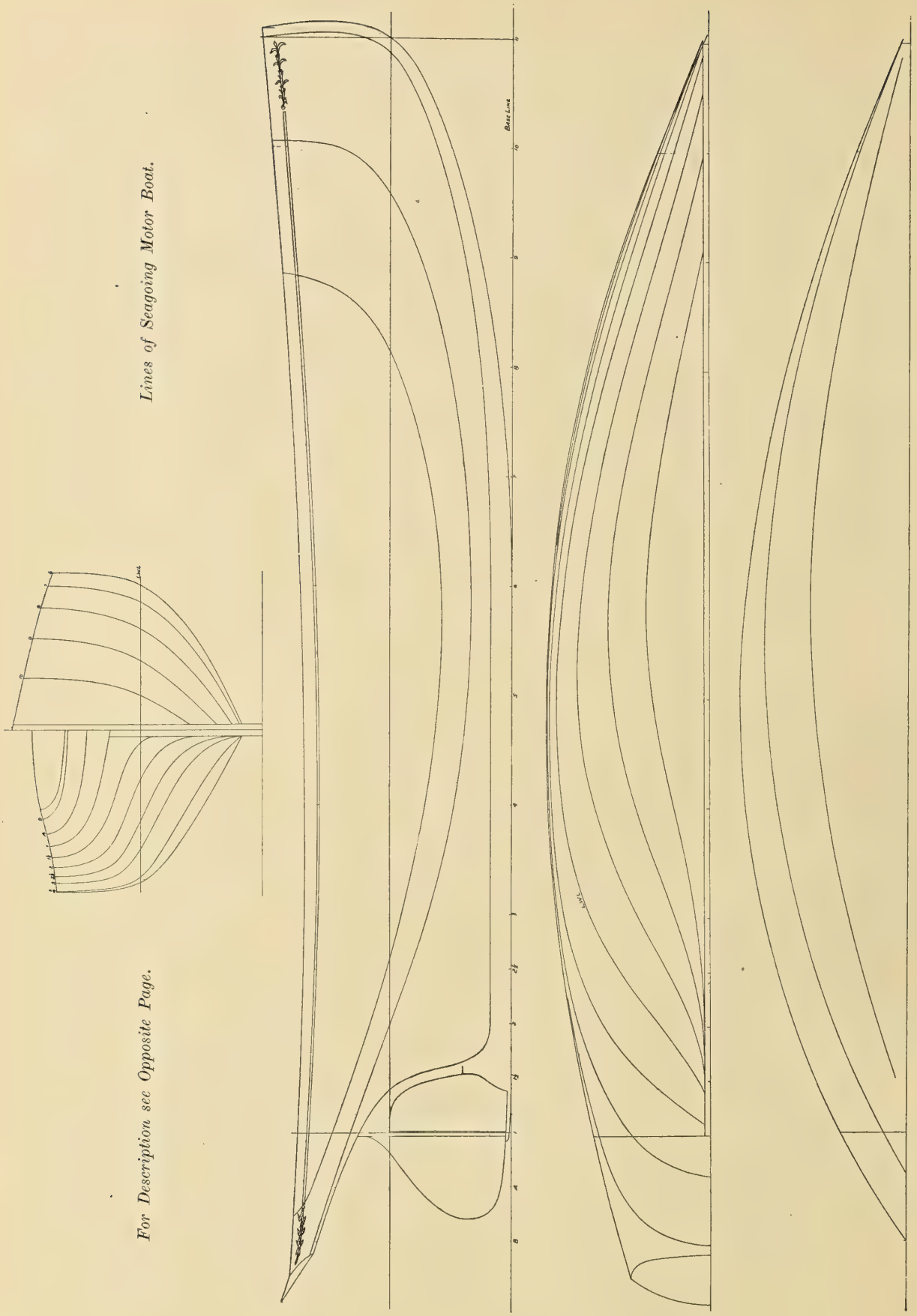


For Description see Page 37.

Construction Plans of Seagoing Motor Boat, Designed by W. B. Stearns, Marblehead, Mass.


Coaming Board Hard Pine 1½"
Sheer Strake Hard Pine
Planking Soft Pine 1"
Extension Berth to add 2'
Stowage and Alcohol Tank Kerosene Tank if necessary
Cabin Top White Pine ⅞" Canvas Covered
Beams Oak 1½" Spaced 8"
6 Swing Ports
Cabin Coaming Pine 1½"
Ledge Oak 1½"
Clamp Oak 3"x1½"
Bilge Stringer Georgia Pine 3"x1½"
Steam Oak 3"x1½"
Hatch Mahogany
Cockpit Coaming Oak ¾"
Floor
Keelson Pine
Ledge Pine 1½"
Keel Oak 3"Sided
Deck White Pine ⅞"
Horn Timber Oak 3"Sided
Oak Knee
Oak Knee
8" Comp Bolts
Rudder Stock & Frame Brass Oak
Oak Board from 3 Oak Plank
Frames Oak 1½" Spaced 8"
Beams White Oak 1½" Spaced 8"
Engine Space Brass Lined
Hatch over Kerosene Tank
Turning Frame
Floor
W.T. Bulkhead Pine ¾"
Floor
Floor
Floor

Lines of Seagoing Motor Boat.



For Description see Opposite Page.

Motor Boat for Sea Service.

There are many persons who like to make short cruises along our coasts who do not want the expense or bother of a steam launch or small yacht, and who at the same time are not impressed with the uncertainties of sail power. For such, a cruising launch of the type here illustrated is a very satisfactory vessel. This particular boat was designed by W. B. Stearns, of Marblehead, Mass., for C. Colburn Clement, of Haverhill, Mass. She might be termed a sea-going motor boat, as she was designed for the purpose of taking her owner on short cruises on the exposed coasts of Maine and Massachusetts.

CRUISING LAUNCH FOR SEA SERVICE, FITTED WITH ALCO-VAPOR MOTOR.

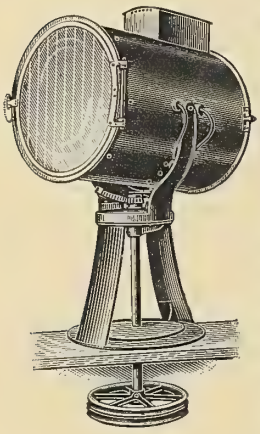
In this case the owner appreciated the need of some more scientific treatment than that which frequently results in the production of a motor boat, for which "any old model" is usually considered good enough. There were certain requirements to be met: the cost was to be kept within reasonable limits, there were to be many conveniences, which one might usually expect only in a large vessel, and the boat was to be strong, comfortable and absolutely seaworthy. The dimensions agreed upon were: Length, 26 ft.; beam, 6 ft. 9 in., and depth, 4 ft. 5 in., with closed cabin 5 ft. in the clear. To keep down the item of cost it was considered best to use a 5-horse power motor instead of 7-horse power, which would ordinarily be used in a boat of such excessive displacement. The improvement in form over the ordinary stock launch hull, however, justified the experiment, for the boat showed as much speed as could be reasonably expected of a craft of her length. Under favorable conditions she has maintained a rate of speed within a fraction of eight knots, and performed excellently in a seaway, being dry, easy in rolling, and absolutely non-capsizable. In a general way the plans here published show the accommodations. The large locker on the starboard side is fitted very ingeniously and completely as a galley, with all the implements necessary for cooking for two persons. The folding lavatory in the toilet compartment, within reach of the galley, is connected by a pump with the fresh water tank, draining directly outboard. This, however, while adding to the convenience of the cook, does not conduce to economy of water. The two sofas in the cabin are fitted to extend so as to make comfortable beds, and numerous lockers are provided for bedding, clothes, etc. The ice box is placed under the seat in the cockpit.

This boat was built by John Stewart, of Wollaston, and the machinery, consisting of an Alco-vapor motor and propeller, etc., was supplied by the Marine Vapor Engine Co., of Jersey City, N. J.

IMPROVED APPARATUS.

Benton Projector Case.

Our illustration shows a new type of projector search light case made by Thomas P. Benton & Son, of La Crosse, Wis. The case is made of heavy galvanized steel reinforced at proper points by angle iron hoops which make it extremely rigid. The hinges and fastenings on both doors are brass and of large size. The pedestal is arranged to bolt to the deck or platform which supports the light, and is shaped so as to be rigid and shed water and also prevent leaking through. The tubes on which are fastened the controlling wheels pass down through the pedestal. (The wheels can be placed between the two pedestal sides if occasion requires.)



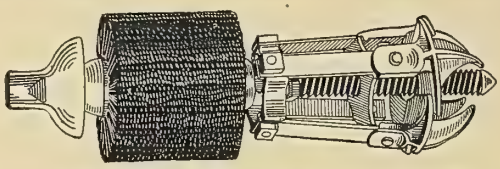
They can be placed close up to the deck and are connected to the handling device in the pilot house by small wire ropes. The wheels can be boxed in and the ropes pass through mouldings, making a neat job. When it is desired to place the light directly over the operator, as on the top of the pilot house, the regular handling wheels are fitted on in place of the rope sheaves. In the pilot house there is placed a device with two drums, around which passes the cables from the rope sheaves. When both drums turn together the light is swung maintaining the angle of deflection to which it is set. A device is provided to change the relation of these drums, which changes the angle of deflection to the one desired. The cut shows a case made with 20 deg. range of deflection both ways from a horizontal line. This would make the center of the ray of light strike the water 55 ft. from the lamp, the projector being 20 ft. above the water.

Combination Flue Brush and Scraper.

This is a new combination of flue brush and scraper manufactured by the St. Louis Steel Wire Brush Co., 620 North Main street, St. Louis, Mo. The scraper cuts the scale off the tubes, which is then pushed out of the tube by means of the steel brush shown, the tube being cleaned in one operation. The scrapers are made of malleable iron and carried on four steel arms and fastened in the center. They are expanded or contracted by turning the rod to the right or left, thereby moving the slide up or down on the threaded rod in the center. The brush is made of fine tempered steel wire, the wires passing entirely through the holes in the iron center and being fastened on the inside, making it impossible for them to come out or lay over, the whole construction being of the best, and designed for hard and rough usage.

Gas Engine Ruhmkorff Coil.

The Varley Duplex Magnet Company, 138 Seventh street, Jersey City, N. J., has brought out a new induction coil for use in igniting the charge in marine gas and gasoline engines, an illustration of which is presented herewith. These coils are built to give a spark 1 to 1 1-2 in. long, with a primary pressure of 4 to 6 volts. It is stated that with the discharge points 3-32 in. apart the flame is very intense, and the ignition is positive beyond any chance. The make-and-break device in the primary of the coil is located outside the cylinder so as to be easy of access. The manufacturers state that the price of the coil is such as to justify its use for ignition purposes by engine builders who have used other methods because

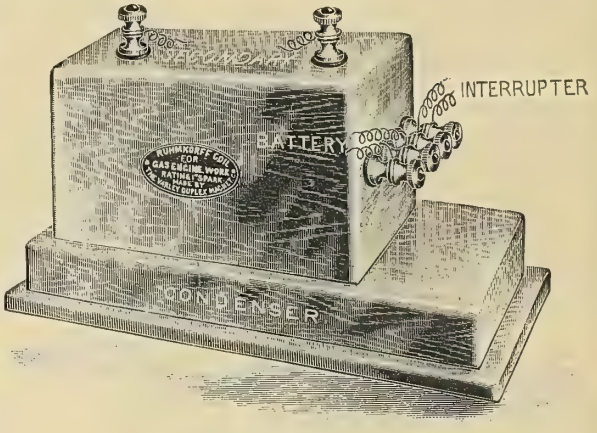


COMBINATION FLUE BRUSH AND SCRAPER.

of low first cost. They further claim that these coils possess points of superiority over those of foreign make heretofore used.

Automatic Check and Stop Valve.

The accompanying engraving shows an automatic check and stop valve designed and manufactured by F. Hennebohle, of Chicago. This form of non-return valve is made extra heavy for high boiler pressure. It is guaranteed in operation to automatically close when the pressure in the boiler falls half a pound below the pressure in the main, and yet not be affected by the ordinary pulsations, and to remain noiseless in operation. When in operation the tendency of the valve is to keep near its seat, and where these valves are fitted to a set of boilers, should a sudden demand for steam be made from the engine, each valve will

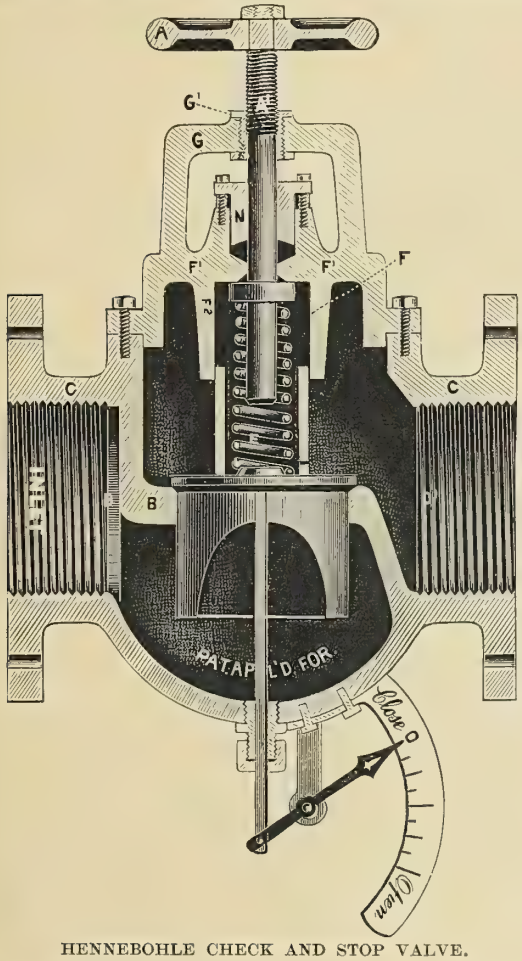


VARLEY RUHMKORFF COIL.

respond equally, and thus, the manufacturer claims, the danger of foaming will be minimized, if not altogether got rid of. Each complete valve is fitted with an indicator so that the opening at any moment can be readily seen and a line obtained on the working of each boiler. In case of mishap to one boiler this valve, if fitted, would isolate it from all the other boilers on the ship, automatically. The manufacturer's address is South Chicago and Erie aves., South Chicago, Ill.

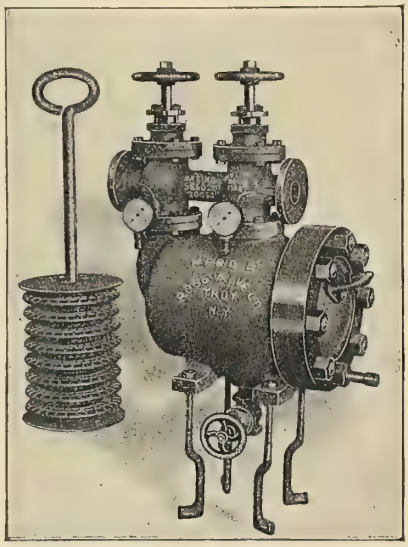
Ross Feed Water Filter.

A well equipped steamer with surface condensing engines carries a feed water filter. The grave dangers which the entrance of oil, in suspension in the feed water, into the boilers occasions are well appreciated by sea-going engineers, and feed filters from being looked upon as luxuries have taken their place as part of the necessary engine room equipment. The apparatus exhibited here is made in this country by the Ross Valve Co., of Troy, N. Y. The filter is placed between the feed pumps and the boiler, and consists essentially of a chamber containing a bag made of the fabric known as "Turkish toweling," so folded as to obtain a large area of filtering surface in a small space. The surface of the bag is formed into a series of deep circular corrugations by being drawn over a bronze skeleton shown in the exterior view, and drawn down between each of the sections



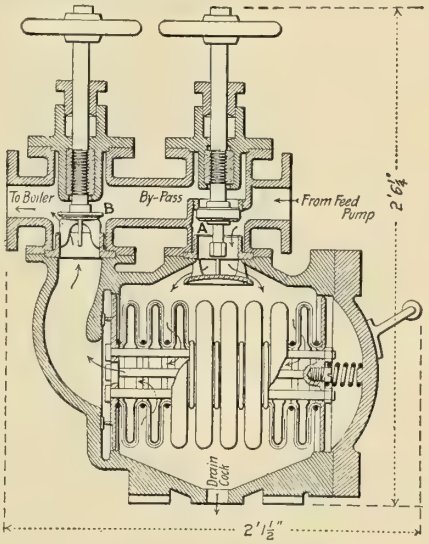
HENNEBOHLE CHECK AND STOP VALVE.

by means of strings wound around it. The area of the filtering surface is made from 250 to 1,000 times the area of the feed pipe, according to the service required. The threads of the Turkish toweling retain the oil until they become saturated with it, while they let the water pass through. The filter is so constructed that the water passes from the outer side of the bag through it and the metal skeleton to the interior of the latter, and thence to the outflow pipe, as shown. The oil gradually clogs up the filtering material, increasing the resistance to the passage of the water. This resistance is indicated by the difference in the readings of the two pressure gauges, one on the inlet and one on the outlet side of the filter. When the difference in pressure reaches 2 or 3 lb. per sq. in. the filter may be cleaned by reversing the direction of the current, allowing the wash water to run to waste, or by changing the filter bag, a fresh one always being kept in reserve. The head of the filter chamber may be opened, the filter bags changed,



ROSS FEED FILTER.

the skeleton and the bag being removed and it and the head replaced inside of five minutes. The washing of the filter by reversing the current of water is done by operating the valves in the following manner: The inlet valve, *A*, is first screwed down and closed; *B* is then closed, and the drain cock opened.

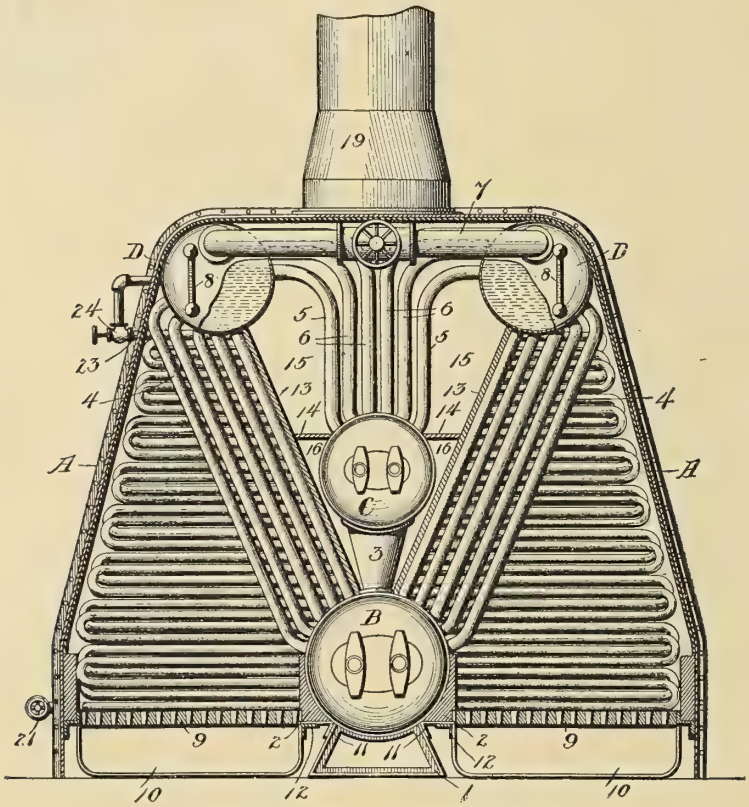


SECTION OF ROSS FILTER.

Valve *A* is then opened a little and the current of water thus created washes the outside of the filter. *A* is then closed and *B* opened, causing water to pass from the boiler through the filter bag from the inside. The valve, *A*, is ingeniously made to perform the double function of a stop-valve and a by-pass valve, as shown in the sectional drawing.

Keene Water-Tube Boiler.

A new type of high pressure water-tube boiler for marine use has been patented under the name of the "Keene Marine Boiler." As shown in the engraving, it consists of one lower, one central and two upper drums connected by banks of tubes, the central and lower drums being connected by three large tubes or water legs (*3*). A fire-box is located on each side of the lower drum. The casing is of sheet iron lined with asbestos. By means of suitably arranged tiling the products of combustion are made to pass three times through the boiler, first under the tiling (*13*) which covers the two lower banks of tubes to the back of the boiler, thence over this tiling and under the horizontal tiling (*14*) to the front, thence to the back of the boiler over the tiling (*14*) and out through the stack, which is situated at the back of the boiler. The circulation is arranged as follows: the water ascends from the lower drum through the outer or lower banks of tubes (*4*) to the upper drums, then descends through the tubes (*5*) to the central drum, and from there through the large legs (*3*) into the lower drum, and so on in continuous circuit. The steam generated in the lower drum, the central drum and the three water legs connecting these two drums finds an easy escape through the upper tubes (*6*), which are not submerged, these being utilized as steam superheating surfaces. The principal patent claim is for a boiler consisting of a central drum, around which are grouped three other drums in triangular arrangement, the drums being connected by banks of tubes and one drum being between two fire-boxes, the entire structure being surrounded by a casing of sheet iron lined with asbestos. Without departing from this claim, the sizes of the drums and tubes and the number of the latter can be changed to conform to particular requirements. It is, however, intended that the drums shall be sufficiently large for a man to enter them, and that the tubes shall be of the "large type." For abstracting the steam, a dome, drum or two separators can be used. As shown in the engraving, there is a double row of interlocking pipes which form a protecting wall at the back of the boiler; these comprise the feed water heater. The coils are connected with the pump, the lower drum, and with one or both of the upper drums. When not feeding water into the boiler the valve or valves (*24*) are kept open so that there shall be a circulation between the upper and lower drums through the coils of the heater. The advantages claimed for this boiler are many: perfect circulation, large grate area and large heating surface, thorough utilization of heat, economy, high pressure, safety, quick steaming, lightness, adaptability to large units, high efficiency, maximum power and minimum weight and space. Further particulars can be obtained by communicating with George J. Rockwell, 631 Washington Boulevard, Chicago, Ill.

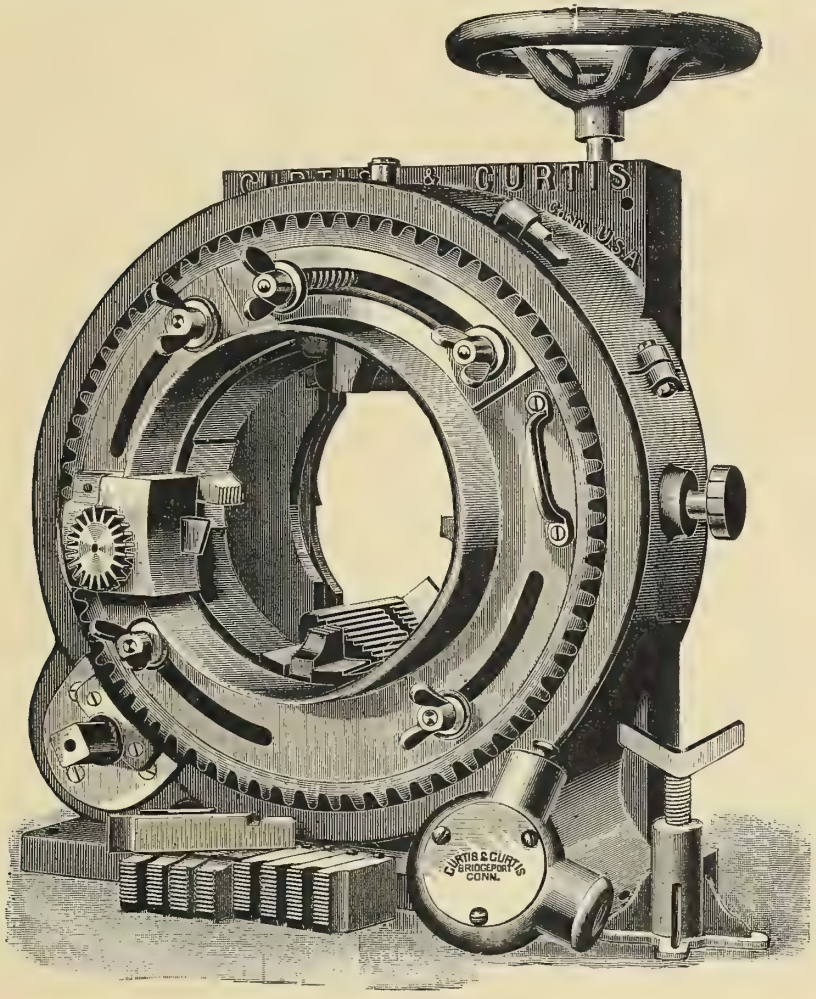


KEENE MARINE WATER-TUBE BOILER.

Forbes' Patent Die Stock.

To produce a machine which, according to its size, will thread pipe from 1-4 in. to 12 in. dia., and yet be quite portable and easily operated, has been the aim of the designer of the Forbes Patent Die Stock here

shown. The labor attendant on the use of ordinary hand die stocks is familiar to many of our practical readers, and in large work this method is really out of the question. Large stationary power machines, while very effective, have the disadvantage that the work must be brought to them instead of the machine being taken to where the work is going on. The illustrations here printed show Forbes' Patent Die Stock. It consists of a die-carrying gear supported and surrounded by a shell and actuated by a small pinion embedded in the side of the shell and working on the large gear, with the pipe vise attached to the back of the machine. To operate it, the pipe is placed through the pipe vise with the end to be threaded against the back of the dies. The die-carrying gear is then revolved by means of a crank on the end of the pinion. As the dies revolve the gear is drawn back into the shell and the dies are thus brought on to the pipe. These dies are adjustable to any variations of fittings, and, when the thread is cut, they can be opened and the pipe taken out without running back or stopping the machine. In cutting off pipe the gear is shoved back in the shell and held by a stop, so as to give it a rotary without a traveling motion. A blade cutter is then inserted in the gear, which is automatically fed forward as the gear revolves. The advantages claimed for this machine are: It is portable and can be carried from place to place and the pipe cut on the spot without the delay and expense of carrying it to the machine. This is very valuable for marine use, as a machine with a capacity even for 12 in. pipe can be carried on shipboard in very small space, and repairs made by the engineering force while at sea. In case it is desired to thread the end of a pipe without disconnecting it and where only one end is exposed, the machine can be slipped on and the work done without taking the pipe down. With this machine pipe even as large as 12 in. can be threaded by one man. Dies can be sharpened by grinding without first drawing the temper, and when one of the set is lost or broken a new one can be supplied without replacing the set. They draw back out of the way when thread is cut, yet always cutting standard sizes, and are adjustable to any variations of fittings. The shells are adjustable for wear, which greatly prolongs the life of the machine. By the addition of a cast-iron base, with necessary gearing and countershafting, the machines can be fitted to run by power, so that they can be used by power as a power machine in the shop or taken from the base and used on outside work as a hand machine. The machines are manufactured by Curtis & Curtis, Bridgeport, Conn.



FORBES' PATENT DIE STOCK.

MARINE ENGINEERING

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In response to the kind inquiries of friends we are happy to be able to state that Mr. H. L. Aldrich has made an exceedingly rapid recovery from the effects of the severe accident which he recently met with, and that he will be able soon to personally express his appreciation of the many sympathetic messages which we have received.

YACHTSMEN and the sport loving public on both sides of the Atlantic are just now deeply interested in the two vessels which will compete this summer, in home waters, for the America's cup. The Columbia, which is to defend the cup, is now under construction at Herreshoff's, Bristol, R. I., and the Shamrock, with which Sir Thomas Lipton, the cup challenger, expects to carry home the trophy, is now building at Thornycroft's, London. Notwithstanding the great feeling of interest manifested by the peoples of the two greatest sport loving nations, it seems to be the chief desire of persons on both sides of the Atlantic who are concerned with the construction of these yachts to withhold all accurate information about them. For this cause those interested have to depend upon conjecture, misinformation and downright untruth, which the press scatters broadcast, for particulars of the design, construction and equipment of these vessels. It might be argued that outsiders have no right to any knowledge of the vessels, and this would be true undoubtedly were it the custom to carry out the contests privately. When the races are to occur, however, the public is duly notified and the race managers understand that thousands of persons will pay handsomely for the privilege of witnessing the matches. In this way the cup contest has come to have a quasi-public character. What object then could the cup contestants have for going to such extremes to hide all details of their plans? Within reason there is only one explanation: that both parties are afraid of each other; that neither will give any details for fear the other will at once incorporate such in his plans, or that he will take some unfair advantage—truly a sportsmanlike spirit! We have no inside information as to where the responsibility must be laid, in either case, for this unsportsmanlike, unscientific and illiberal conduct. The position of a croaker is neither pleasant nor popular, but we do not hesitate to say that a contest begun in such a spirit of empiricism does not give promise of that noble and fraternal conduct which should make the conclusion of this international event. It is worth while to examine further into the strange situation. Our British cousins seem on this occasion to have taken the lead in secretiveness. Only lately news was cabled of the arrest of two unoffending persons who were deprived of their liberty because they happened to be in a boat on the river in the vicinity of the works where the Shamrock is building and had a camera in their possession. It is to be assumed in each case that the designer is at the top of his profession and consequently has his own ideas of model and material. Is it, therefore, reasonable to believe that either designer would slavishly imitate his competitor? Would he adopt some feature of design, not knowing what relation it bore to the design as a whole, or to what extent such fraction of design was interdependent on the other components of the vessel for the result in its entirety? Idiocy can imitate, brain only can originate, and no one on either side of the Atlantic is going to win the races by mediocrity. It would be unreasonable, perhaps, to expect that the contending parties would disclose all their plans. Yet a true sportsmanlike spirit would give those interested a general idea of the vessels, and would at the same time maintain a discreet silence as to what the vessels might be expected to do: something that only trial can tell. There is no secret, of course, as to the determination of both contestants to win—the foundation of all sport. We have gone into this at some length for the purpose of calling attention to a narrow

spirit in vessel construction which we deplore, and also for the sake of the contrast which such a spirit offers to the spirit of our Navy. We believe there is nothing that contributes more to the glorious memory of our recent victories than the remembrance of the noble and truly sportsmanlike spirit which characterized the conduct of our Navy throughout. Prior to the war it was possible for our late enemy to not only become familiar with the construction of our vessels in detail, but to thoroughly understand their performances, and to verify most of the information by personal inspection. There is no finer courtesy afloat than is to be found on the American man-of-war. In the Government publications and in the proceedings of the learned societies there is full and free discussion of the merits and limitations of our ships. In effect the Navy says: "You can have all the information you want about our ships, but don't forget that when the time comes we will lick you to a standstill." There is no secrecy, no hugger-mugger, no effort to take advantage or to spring some unlooked for device at the last moment, but with open hearts and manly courage our sailors take their ships into the race that leads to death or victory. So long as this spirit animates our sailors so long will the American Navy be invincible. Search the pages of history for a finer example of chivalry and you will not find it even in the chronicles of the crusades. To dwell on this manifestation of National character incites such feelings of love of country and pride of race as are beyond all human expression.

IN our educational department in this issue the reader will find an extremely interesting paper on sketching by Professor C. W. MacCord, which, though one of a series primarily intended for beginners, can be read with profit by the most experienced. There are one or two points made by the author, who, by the way, is one of the greatest living authorities on all matters pertaining to engineering drawing, that should find a place in the notebook of every engineer. One is that the drawing or sketch should be such that by its aid the workman can make what is required without the possibility of mistake. Any one who has had much practical experience will recall cases in which a drawing was not of this kind. The three most frequent causes of error, perhaps, are insufficiency of detail, or the reverse—over-elaborateness of detail and thus confusion—and the unfamiliarity of the draughtsman with workshop limitations. The first two can be more easily guarded against than the last, unless the designer has had sufficient shop experience. The lack of this is responsible for much labor wasted on drawings for impossible castings, that no foundry could turn out, or on engine parts that no machine in the builder's shop could handle, at least with anything like economy. The misuse of materials and the lack of sufficient clearance for moving parts are also common errors. The error of leaving out necessary details is most common with beginners, who often assume that because they are perfectly familiar with the object sought to be represented the mechanics in a shop, say 1,000 miles away, should be equally informed. Marine engineers who are often far distant from shops in case of breakdown cannot be too careful in this respect. The experienced draughtsman, on the contrary, too often goes to the other extreme and gets out most elaborate plans, works of art in fact, which are practically worthless. This is frequently due, as Professor MacCord points out, to the use of unnecessary dotted lines. In the end elevation of an engine, for example, dotted line is laid on dotted line until the drawing looks like a tangled skein of thread, and probably not even the draughtsman himself could, after a lapse of time, take off the dimensions with a scale. This is especially annoying and misleading when blueprints are used. The shrinkage of the print is such that the drawings cannot be read by scale and there is no room for figured dimensions. Most of the troubles with drawings arise from a misconception of their purpose. The trained draughtsman who is confined to the board often grows into the belief that the end and aim of his work is to produce fine drawings, whereas in reality his work is only a means to an end—the satisfactory construction of an efficient and economical machine with the facilities at hand.

IN commenting upon the new Naval programme in our last issue the number of protected cruisers provided for was given as three. This is an error, as the correct number is six, which, with the three battleships and three armored cruisers, makes a total of twelve new vessels. The Navy Department originally recommended the construction of fifteen vessels, but Congress in its wisdom cut this down to twelve ships nominally and six practically, as the armor plate restriction holds up indefinitely the construction of the three battleships and three armored cruisers. Meanwhile it is a consolation to know that our Navy will soon be strengthened by the addition of several vessels now under construction.

MARINE BREAKDOWNS AND LOSSES.

S.S. Norseman Ashore at Marblehead.

The Warren line steamship *Norseman* went ashore in a fog on Marblehead Neck early in the morning of March 29 while trying to make Boston harbor without a pilot. The shore here is unusually rocky, with boulders scattered about on the bottom into deep water. She struck about 500 yards off shore and filled, so that she drew 31 ft. forward and 19 ft. aft, about 100 ft. of her keel from the stern post forward overhanging a ledge on which she lay. The life saving crew was promptly in attendance, and the crew and officers were taken ashore in the breeches buoy. The captain was the last to leave, and his journey toward the shore is depicted in the reproduction of the snapshot here printed.

As soon as the owner's agents were notified they enlisted the services of the Boston Tow Boat Company, and Captain William I. Humphrey, of that well-known wrecking concern, went down to make a survey of the *Norseman*. As a result it was decided to put large centrifugal pumps aboard and attempt to drain the vessel. She has seven watertight compartments and in each a pump, with a capacity of ten tons a minute, was placed in the 'tween decks. On the upper deck a boiler was placed for each pump. It was then found that the pumps could reduce the water in all the holds except the forward one, and here the pump was not able to make any impression. Pumping was here discontinued and the hatches were put on in the lower 'tween decks and shored down, and the same treatment was applied to the deck all over, so that the vessel could float on that deck at the forward end. Divers were also sent down, but they could not accomplish anything, as the wounds were all under the ship. The wreckers next laid anchors and cables out astern of the ship, about four points on the port quarter, so as to haul her off clear of Tom Moore's rocks, inside of which the *Norseman* lay. At the first tide the vessel was hauled about 50 ft., which was sufficient to haul her bow out of the hole in which it rested and put the ship more nearly on an even keel. Divers were now able to get at the holes in the bottom and to fill some of the holes with oakum, blankets, plugs and wedges, and so check the inflow that the pumps could reduce the depth of water in the holds very considerably. Meanwhile the cargo was being pulled out and discharged into lighters alongside and towed to Boston. At the next high tide, though the vessel was drawing 23 ft. forward, 19 ft. aft and 18 ft. at the bridge, the wreckers hauled her toward deep water about 60 ft. This process was repeated at the next following high tide, and finally on the morning of April 7, with the assistance of some ocean swell that was rolling in, the *Norseman* was floated. She was then towed to the Simpson dry dock, in Boston, and docked for a survey by the underwriters' representatives. The damage she sustained was very serious, as a little forward of amidships her entire bottom was almost torn out. The vessel had a mixed cargo, insured for $250,000. It consisted in part of china clay and bleaching powder, which were destroyed, and wool and textile fabrics, which were much damaged.

The *Norseman* is a four-masted iron single-screw vessel of 4,550 tons register, built in 1882 by Laird Bros., Birkenhead-on-the-Mersey. Her dimensions are: Length, 392 ft.; beam, 44 ft.; depth, 25 ft. She is fitted with compound engines, with cylinders 48 in. and 85 in. by 60 in. stroke. She was classed 100 A1 at Lloyds.

Boiler Explosion on H.M.S. Terrible.

As a result of the coroner's investigation into the recent fatal accident on the British cruiser *Terrible* a verdict was rendered by the jury exonerating the officers of the vessel and recommending that the Admiralty discontinue the use of welded boiler tubes. The evidence showed that the explosion occurred while the cruiser was steaming at about the rate of 14 knots on her return trip home from Malta. The engineer officer who was on watch testified that he heard "a hissing noise" in one of the boilers, and fearing that a leak had developed he gave the order to draw fires. One of the firemen in obedience opened the furnace door, and instantly there was a loud report, and steam and flame came out through the door in an explosive blast. The section of the stokehold in which the boiler was located instantly became filled with steam, and men from an adjoining compartment groped their way in and dragged out the firemen who had been injured; the stoker who had opened the door suffered fearfully, and died soon after being taken to the sick bay.

The witness believed that the failure of the tube had been caused by deterioration of the metal owing to the work it had gone through. The tube was of the welded variety, and he believed that solid drawn tubes were more reliable. It also developed in the inquest that on the outward trip of the *Terrible* a tube had burst and two men were slightly scalded as a result. In all three tubes "had gone" during the voyage. The disaster caused a temporary panic, and it was difficult to get the men to stand up to their work afterward, and when firing they endeavored to keep as far from the furnace doors as possible. The mishap was also variously credited to shortness of feed water, and to leaky condensers, which permitted salt to get into the boilers. At the time of the mishap the gauge pressure was only 180 lb. per sq. in.

The *Terrible*, as most of our readers are doubtless aware, is one of the two largest cruisers afloat, and she has always been looked upon as an experiment in many respects. Her machinery has given more or less trouble since she was put in commission. She was built at Clydebank in 1895, and is a protected cruiser of these dimensions: Length, 500 ft.; beam, 70 ft.; draught, 27 ft.; displacement, 14,200 tons. Her twin screw engines are of the four crank triple-expansion type, giving 24,000 I. H. P. collectively with induced draft, and a speed of 22 1-2 knots. She is fitted with forty-eight Belleville water-tube boilers, placed in eight compartments, with a total grate surface of 2,200 sq. ft. and heating surface of 67,800 sq. ft. She has four funnels and two military masts, and is altogether a huge and powerful looking war vessel of the cruiser type.

Inquiry into Loss of S.S. Londonian.

The British Board of Trade has held an inquiry into the loss of the British steamship *Londonian*, 5,000 tons, at sea, and found that the ship was in every way well found and well built. Her loss is attributed indirectly to a bunch of cotton waste. The vessel was fitted with a steam steering gear which employed a tooth quadrant and gear. When one of the crew was cleaning up he left a handful of waste in the case which inclosed the gear, with the result that later it worked in between the circular rack in the quadrant and the driving pinion and locked the gear. This occurred at a critical moment, when a gale was blowing and the sea was running high. Before the rudder could be got to move again the ship fell off into the sea and both cattle and cargo shifted to leeward. The vessel was in consequence so inclined that the sea cocks were above water and the engines had to be stopped for lack of circulating water for the condensers. By this time the vessel had become unmanageable, and was finally abandoned in mid-ocean. The breakdown of steering gear on large steamships, from one cause or another, in bad weather, has become of late a matter of frequent occurrence. In some instances the vessel, being fitted with twin screws, was enabled to keep steerage way until repairs could be made or the supplementary hand gear put into service.

The *Londonian* was a four masted steel steamer, in dimensions: Length, 450 ft.; beam, 49 ft.; depth, 30 ft. 9 in.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—MATERIALS OF ENGINEERING CONSTRUCTION—III.

BY DR. WILLIAM FREDERICK DURAND.

(12) *Various Specifications for Structural Steel.*

U. S. NAVY.

COMPOSITION OF BOILER PLATES.

Phosphorus: Not over .035 of one per cent.

Sulphur: Not over .040 of one per cent.

Elastic Limit: Not less than 35,000 lb. per square inch.

Cold Bending Test.—One piece cut from each shell and curved head plate, as finished at the rolls for cold-bending test, must bend over flat on itself without sign of fracture.

STRENGTH OF FURNACE AND FLANGE PLATES.

Tensile Strength: Between 52,000 and 60,000 lb. per square inch.

Elongation: Not less than 26 per cent in 8 in.

Quenching Test.—One piece shall be cut from each furnace or flange plate as finished at the rolls for quenching test, and after heating to a dark cherry red,

VIEWS OF THE S.S. NORSEMAN ON THE ROCKS AND THE CAPTAIN COMING ASHORE IN THE BREECHES BUOY.

STRENGTH OF SHELL PLATES.

Tensile Strength: Between 65,000 and 73,000 lb. per square inch.

Elongation (transverse): Not less than 22 per cent in 8 in.

Elongation (longitudinal): Not less than 25 per cent in 8 in.

plunged into water at a temperature of 82 deg. F. The piece thus prepared must be bent double round a curve of which the diameter is not more than the thickness of the piece tested, without showing any cracks. The ends of the pieces must be parallel after bending.

BOILER RIVETS.

Kind of Material.—Steel for boiler rivets must be

made by the open-hearth process and must not show more than .035 of one per cent of phosphorus, nor more than .04 of one per cent of sulphur, and must be of the best composition in other respects.

Tensile Tests.—These specimens for rivets for use in the longitudinal seams of boiler shells shall have from 62,000 to 70,000 lb. per square inch tensile strength, with an elongation of not less than 25 per cent in 8 in.; and all others shall have a tensile strength of from 54,000 to 62,000 lb. per square inch, with an elongation of not less than 28 per cent in 8 in.

Shearing Tests.—From each heat, rivets must show a shearing strength of at least 51,000 lb. per square inch for rivets to be used in longitudinal seams of boiler shells, and at least 44,000 lb. per square inch for all other boiler rivets. Rivets to be driven at the same heat used for working.

Hammer Test.—From each lot six rivets are to be taken at random and submitted to the following tests:

(a) Two rivets to be flattened out cold under the hammer to a thickness of one-half the diameter of the part flattened without showing cracks or flaws.

(b) Two rivets to be flattened out hot under the hammer to a thickness of one-third the diameter of the part flattened without showing cracks or flaws—the heat to be the working heat when driven.

(c) Two rivets to be bent cold into the form of a hook with parallel sides without showing cracks or flaws.

RODS, SHAPES AND FORGINGS FOR BOILER BRACING.

Kind of Material.—Steel for stay rods and braces must be made by the open-hearth process, and must not show more than .035 of one per cent of phosphorus, nor more than .04 of one per cent of sulphur, and must be of the best composition in other respects.

Treatment.—All material for boiler bracing must be annealed after working.

Tensile Test.—Bracing coming into contact with the fire must have a tensile strength of from 50,000 to 58,000 lb., and an elongation of not less than 28 per cent in 8 in., or of 33 per cent in 2 in. in case 8-in. specimens can not be secured. Other bracing must have a tensile strength of not less than 65,000 lb., and an elongation of not less than 24 per cent in 8 in., or of 30 per cent in 2 in. in case 8-in. specimens can not be secured.

Bending Test.—One bar 1-2 in. thick, cut from each lot of the bracing coming in contact with the fire, must stand bending double to an inner diameter of 1 in. after quenching in water at a temperature of 82 deg. F., from a dark cherry-red heat without showing cracks or flaws. A similar piece cut from each lot of the other bracing must stand cold bending double to an inner diameter of 1 in. without showing cracks or flaws.

Opening and Closing Tests.—Angles, T bars, etc., are to be subjected to the following additional tests: A piece cut from one bar in twenty to be opened out flat while cold; a piece cut from another bar in the same lot shall be closed down on itself until the two sides touch without showing cracks or flaws.

CONNECTING AND PISTON RODS AND VALVE STEMS.

Tensile Strength: Not less than 80,000 lb. per square inch.

Elongation: Not less than 26 per cent in 2 in.

Elastic Limit: Not less than 50,000 lb. per square inch.

Bending Test.—One longitudinal bar 1-2 in. thick, cut from each forging, must stand bending double, when cold, to an inner diameter of 1 in. without showing cracks or flaws.

THRUST LINE AND PROPELLER SHAFTING.

Tensile Strength: Not less than 80,000 lb. per square inch.

Elongation: Not less than 25 per cent in 2 in.

Elastic Limit: Not less than 50,000 lb. per square inch.

CRANK SHAFTS.

Tensile Strength: Not less than 58,000 lb. per square inch.

Elongation: Not less than 30 per cent in 2 in.

Bending Test.—Bars 1-2 in. thick, cut from each length of shaft, must stand bending double to an inner diameter of 1 in. without showing cracks or flaws.

STEEL CASTINGS.

Phosphorus: Not more than .06 of one per cent.

Tensile Strength: Not less than 60,000 lb. per square inch.

Elongation (for moving parts): Not less than 15 per cent in 8 in.

Elongation (other castings): Not less than 10 per cent in 8 in.

Bending Test.—A bar 1 in. square shall bend cold without showing cracks or flaws, through an angle of 120 deg. for castings for moving parts of machinery, and 90 deg. for other casting, over a radius not greater than 1 1-2 in.

U. S. INSPECTION REQUIREMENTS FOR BOILER PLATE.

Phosphorus: Not more than .06 of one per cent.

Sulphur: Not more than .04 of one per cent.

Elongation (1-4 in. and under): 25 per cent in 2 in.

Elongation (1-4 in. to 7-16 in. inc.): 25 per cent in 4 in.

Elongation (7-16 in. to 1 in. inc.): 25 per cent in 8 in.

Elongation (1 in. and over): 25 per cent in 6 in.

Reduction of Area at Rupture (1-2 in. and under): Not less than 50 per cent.

Reduction of Area at Rupture (1-2 in. to 3-4 in.): Not less than 45 per cent.

Reduction of Area at Rupture (3-4 in. and over): Not less than 40 per cent.

AMERICAN BOILERMAKERS' ASSOCIATION REQUIREMENTS.

Phosphorus: Not over .04 per cent.

Sulphur: Not over .03 per cent.

Tensile Strength: 55,000 to 65,000 lb.

Elongation (3-8 in. and under): 20 per cent in 8 in.

Elongation (3-8 in. to 3-4 in.): 22 per cent in 8 in.

Elongation (3-4 in. and over): 25 per cent in 8 in.

Cold Bending.—For plates 1-2 in. thick and under, specimen must bend back on itself without fracture. For plates over 1-2 in. thick, specimen must bend 180 deg. around a mandril one and one-half times thickness of plate without fracture.

BRITISH BOARD OF TRADE REQUIREMENTS.

Tensile Strength of Plates Not Exposed to Flame: 60,480 to 71,680 lb. per square inch.

Tensile Strength of Plates Exposed to Flame: 58,240 to 67,200 lb. per square inch.

Elongation: From 18 to 25 per cent in 10 in.

STANDARD SPECIFICATIONS ADOPTED BY THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

Special Open-hearth Plate and Rivet Steel.

Steel shall be of four grades, as follows: *Extra Soft, Fire-box, Flange* or *Boiler*, and *Boiler Rivet Steel.*

Extra Soft, Fire-box and Boiler Rivet Steel: Maximum phosphorus, .04 per cent; maximum sulphur, .04 per cent.

Flange or Boiler Steel: Maximum phosphorus, .06 per cent; maximum sulphur, .04 per cent.

PHYSICAL PROPERTIES.

Extra Soft and Boiler Rivet Steel.

Ultimate Strength: 45,000 to 55,000 lb. per square inch.

Elastic Limit: Not less than one-half the ultimate strength.

Elongation: 28 per cent.

Cold and Quench Test: Bends 180 deg. flat on itself without fracture on outside of bent portion.

Fire-box Steel.

Ultimate Strength: 52,000 to 62,000 lb. per square inch.

Elastic Limit: Not less than one-half the ultimate strength.

Elongation: 26 per cent.

Cold and Quench Test: Bends 180 deg. flat on itself without fracture on outside of bent portion.

Flange or Boiler Steel.

Ultimate Strength: 52,000 to 62,000 lb. per square inch.

Elastic Limit: Not less than one-half the ultimate strength.

Elongation: 25 per cent.

Cold and Quench Test: Bends 180 deg. flat on itself without fracture on outside of bent portion.

(13) *Special Properties of Steel.* Mild or low carbon steel may be welded, forged, flanged, rolled and cast. It can not be tempered or hardened with a proportion of carbon lower than about 3-4 of one per cent. High carbon steel can be welded only imperfectly and if very high in carbon not at all. It can be forged with care, and cast into forms as desired. It can be tempered or hardened by heating to a full yellow and quenching in cold water or by other means, and then drawing the temper to the point desired.

Mild steel should not be worked under the hammer or flanging press at a low or "blue" heat, as such working is found in many cases to leave the metal brittle and unreliable. Steel in order to weld satisfactorily should have a low proportion of sulphur, and special care is required in the operation, because the range of temperature through which the metal is plastic and fit for welding is less than with wrought iron.

In the operation of tempering, the steel after quenching is very hard and brittle. In order to give to the metal the properties desired, the temper is drawn down by heating it up to a certain temperature, and then quenching again, or, better still, allowing it to cool gradually, provided the temperature does not rise above the limiting value suitable for the purpose desired. If the reheating is done in a bath of oil the conditions may be kept under good control and the final cooling may be slow. If the reheating is in or over a fire the control is lacking and the piece must be quenched as soon as the proper temperature is reached. This is usually determined by the color of the oxide or scale which forms on a brightened surface of the metal. The following table shows the temperatures, corresponding colors, and uses for which the various tempers are suited:

430°	Faint yellow.	Hardest and keenest cutting tools.
450°	Straw yellow.	
470°	Full yellow.	Cutting tools requiring less hardness and more toughness.
490°	Brown yellow or orange.	
510°	Purplish.	Tools for working softer materials, or those required to stand rough usage.
530°	Purple.	
550°	Light blue.	Spring temper. Used for tools requiring great elasticity or toughness, or for working very soft materials.
560°	Full blue.	
600°	Dark blue.	

(14) *Special Steels.* In the common grades of steel the valuable properties are due to the presence of carbon modified in some degree by other ingredients as already described. There are other substances which by uniting with iron in small proportions are able to give to the combination increased strength or hardness or other valuable properties. We have thus various special steels in which the properties may be due to the presence of both carbon and other ingredients, or due chiefly to special ingredients other than carbon. Of these special steels we may note the following:

Nickel steel, containing somewhere about 3 per cent of nickel and varying amounts of carbon, is found to have increased strength and toughness as compared with ordinary steel. Nickel steel is most extensively used for armor plate, though to some extent it has been employed in Government work for screw-shafts and for boiler plates. For the former purposes it has given excellent satisfaction, but for the latter use difficulty has been met with in obtaining plates free from surface defects.

Chrome steel, containing from .5 to 1.5 or 2 per cent of chromium may be made excessively hard, but it is not always reliable, and is not regarded with general favor.

Tungsten steel or *mushet steel* is a steel containing carbon and tungsten, the latter in proportions as high as 8 to 10 per cent. This steel must be forged with care and is excessively hard. The hardness is not increased by tempering, but is naturally acquired as the metal cools. Hence it is said to be self-hardening. Some specimens contain also small amounts of manganese and silver. Its chief use is for lathe and planer or other cutting and shearing tools where excessive hardness is required.

(15) *Uses of Steel in Marine Construction.* In modern practice mild or structural steel is used entirely in the construction of ships.

The same general class of material is used for all parts of boilers, though the tubes are still sometimes made of wrought iron.

Cast steel is used for various parts of engines such as pistons, crosshead blocks, columns, bed-plates, bearing pedestals and caps, propeller blades, and for many small pieces and fittings. Pistons are made almost exclusively of cast steel. For most of the other items mentioned cast iron is still used, probably to a larger extent than cast steel, especially where the castings are large and complicated in form, as with columns and bed-plates.

Forged steel is used for columns, piston-rods, connecting-rods, crank and line shafting, and for many other smaller and minor parts.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS—VII.

BY PROF. C. W. MAC CORD.

The importance of a judicious selection and arrangement of the views has been already mentioned more than once. But we make no apology for again calling attention to it, because experience has shown that mechanical drawings can be made which are theoretically correct and accurately executed, and, in spite of all, are difficult to read and to work from.

This may be due to more than one cause: the first, as we conceive, follows from the fact that in the discussion of the theory, the construction of three views is in the majority of the illustrations desirable, if not indeed necessary. And we have known cases where the inference has been drawn, and, worse still, acted on, that three views of the whole thing must be made. That this is not so was illustrated in the sketch of the crank and crank-pin, Fig. 28,* and it is shown in a still more emphatic manner in the accompanying sketch of the connecting-rod, Fig. 29.

In this case it is quite clear that an end view of the cross head end of the rod, which is forked, would have been not only useless but obscure. Of course it might easily enough be made, but if it were introduced in a working drawing the chances are that the mechanic would think it was put there for some good reason, imagine it his duty to find out what that reason was, and waste time in the vain attempt. In like manner a top view of the crank end would be equally useless, although one of the forked end is absolutely necessary. In relation to this, one rule applies in all cases, and that is that the drawing or the sketch, as the case may be, must be such that by its aid the work-

*See February, 1899, issue of Marine Engineering, page 43.

man *can make what is required without the possibility of mistake.* This condition being satisfied, the draughtsman's work is done and his responsibility ends.

Fig. 29 ilustrates a case (of frequent occurrence) in which it is wholly unnecessary to attempt to sketch the whole object; much space is saved by breaking out the greater part of the shank of the rod, and at the same time the two ends can be drawn on a larger scale and, therefore, more clearly.

The same expedient may be, and often is, adopted in making an instrumental drawing, which may be made more complete by the addition of a drawing of the whole shank, or at least a side view of it, on a small scale. This addition would be necessary in the sketch as well were the shank made, as it often is, with a swell in the middle; but the fact that it is *not* given is a positive indication that there is in this case no swell, but that the rod tapers uniformly from its least diameter to the greatest.

Another cause of obscurity in otherwise perfect drawings is a mistaken impression that everything which is shown in one view must be shown in the others, which often leads to the introduction of a confusing multiplicity of dotted lines. But if any part is sufficiently shown in one view it is not necessary to

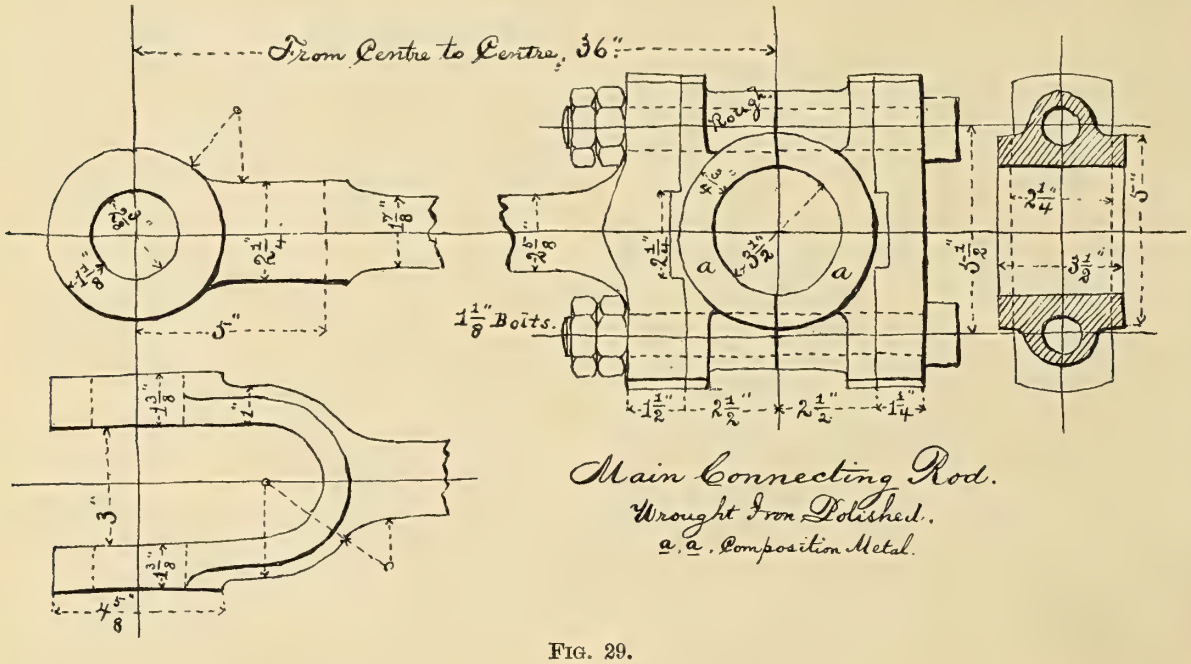


FIG. 29.

show it in another one. For instance, the bolts of the pillow-block end in Fig. 29 are fully defined in the side view, it being understood that a square head or nut is always drawn with the flat side toward the observer, and a hexagonal one, with *one* flat side similarly placed, in *any view in which the bolt is shown "side on."* Now something in the way of an end view is necessary here, but it would display very bad judgment to make this an outside view of the whole, as is sometimes done; it is perfectly obvious that many dotted lines would be required, much to the detriment of clearness. Instead of that a view of the "butt brass" (the one next to the shank of the rod) is alone given, the rod being taken apart and everything else removed. This view is taken from the right, looking toward the left, and, supposing a film cut off just beyond the center line, the brass is shown in section, thus clearly exhibiting its conformation.

Before dismissing this sketch a little may be said in regard to the annotation. The instruction, *"Wrought Iron Polished,"* implies that the greater part of the structure is of that material and that all parts are to be polished which are not marked *"Rough,"* as for instance certain portions of the brasses. The parts *not* of wrought iron are designated by reference letters explained in the annotation as *"a, a, Composition Metal."*

Mention may here be made of a method sometimes adopted of distinguishing different metals or materials by means of conventional variations in the style of "sectioning" or hatching of parts shown in section. Nothing of that kind, of course, is possible in making sketches; and in regard to instrumental drawings, where it is possible, it is to be noted that since there is no universal system by which the various materials can be positively recognized, nothing yet devised is a perfect substitute for reference letters with proper marginal explanations. These are neat, easily made and cannot be misinterpreted. For the benefit of those of our readers who propose to make finished drawings it may be added that all systems of "conventional section-lining" which have yet been proposed are open to the objections that they are difficult of execution, waste much valuable time, are hideous in appearance, and, well or ill done, they ruin the effect of the best executed drawing.

In the preceding article a passing allusion was made to the fact that skill in making free-hand sketches in good mechanical proportion is a qualification of special value to the designer. Indeed a fair degree of skill in this direction is absolutely essential in designing a new machine, if it be at all complicated. No matter how clear a conception has been formed as to the general arrangement of the whole and the relations of the parts, some visible record of that conception, to which reference may be made on occasion, is necessary before the designer can proceed with confidence of success in the elaboration of details, and this record is as a matter of course made in the form of a sketch.

To be sure, this first skeleton is not necessarily wholly free-hand, since certain definite dimensions are often assigned as a basis, such as the bore and stroke of a steam engine, specific movements of given pieces, which must be reduced to settled proportions, and many other conditions which may indicate within close limits some leading features of the skeleton diagram, so that instrumental construction may be absolutely necessary in preparing as one may say the foundation of the contemplated structure. But the

first steps in filling out the skeleton into the complete body is ordinarily dependent upon free-hand work, what may be called a sketch plan being thus produced, serving as a guide in subsequent operations, but subject to alterations as they may be suggested or perhaps required in the development of the scheme.

In simple cases it may be possible to proceed at once with the laying out of details, these being added one by one to the sketch plan as they are completed; but this is not at all a safe course in dealing with complicated mechanisms, where it is usually advisable and often imperative to make upon the sketch plan itself such representations of at least those parts which are immediate neighbors as will give reasonable assurance that no interference will occur when the details are finally worked out.

All this must obviously be done largely with the free hand, and it is equally clear that the sketch will be the better in the precise proportion in which the details as sketched resemble in form and approximate in dimensions the working drawings when eventually reduced to scale.

And again it must be recollected that the problems presented in the process of designing a machine are seldom so sharply limited as to admit of but one solution which excludes all consideration of different ones. On the contrary the desired object can, far more often that not, be accomplished in several different ways, each having advantages of its own, and a selection can be made only by comparison, for which reasonably accurate sketches are absolutely indispensable. On all accounts then it is a most desirable accomplishment to be able to sketch mechanical details in proper proportion; and in acquiring it, certain lines of practice may be suggested as likely to be of benefit to those who are industriously disposed.

First of all is to be named the making of sketches directly from the object, without *measurement*. It is better at first to begin with comparatively small objects, such as minor details, and to make the sketch of full size. In this way the relation between the drawing and the thing drawn is better fixed in mind, so that the operator becomes the more able, upon examining a full-size drawing, to form an adequate mental conception of the actual appearance of the machine itself. *After the sketch is finished* both the object and the sketch should be measured, in order to ascertain the closeness of the approximation. If the object be large, the sketch may be made on a reduced scale, and when completed the test is made as before by measurement; a leading part, as for instance the diameter of a journal in the sketch, being compared with it actual size, gives the scale of reduction, and all other parts should be found reduced in the same proportion.

Next to this may be named the making of free-hand copies of working drawings. This is obviously beneficial, since in designing the very object is to make sketches which shall resemble working drawings as closely as possible. Of course, in this kind of practice the proportions of the original are to be preserved, but the scale may be varied with advantageous results.

And still again the making of sketches from memory will be found of the greatest benefit, and that no less for the professional than for the tyro. In doing this it is necessary to form a clear mental conception of the work in hand, very closely akin to that which a designer must have. In a word, the operator to be successful must see not only the lines he is making with his physical eye, but also (with his mental eye) the object itself, and he should see the one as clearly as the other. Sketches may be made in this way, either from the recollection of an object examined and studied or from that of a working scale drawing, and when practicable the accuracy of the sketch should be tested by subsequent comparison with the original. This desired power to sketch in proportion is to some extent a natural gift, but by faithful work along these lines it may be cultivated and greatly strengthened.

ENGINEERS' DICTIONARY—XVII.

Expansion Joint.—A form of joint in a steam pipe which will allow of expansion or contraction lengthwise without buckling or straining the pipe. The common form of expansion joint is shown in Fig. 70, and consists of a recessed portion on one part of the pipe into which the other part fits as shown. The space left between the two thus forms a stuffing box into which packing is compressed by means of the gland as shown. The two parts of the pipe are thus free to slide a little way, one relative to the other, while the joint is kept tight by means of the stuffing box and gland in the usual way. As may be seen, the

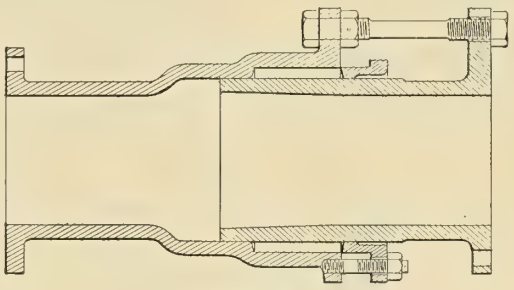


FIG. 70.

steam pressure within the pipe, especially if it contains a bend, will tend to force the two portions of the joint apart, and thus open the pipe at this point. To guard against this, struts or safety stays should be fitted. In the figure one of a pair of such stays is shown by the long bolt on the top. In special and more complicated forms, known as balanced or equilibrium expansion joints, these forces are more or less completely balanced at the joint itself.

Feathering Propeller.—A form of screw propeller in which the blades may be turned about a radial axis, thus changing their pitch, or even turned so far that their direction of inclination relative to the axis is reversed and the propeller is changed from right-hand to left-hand, or *vice versa*. With such a propeller backing is effected by simply allowing the engine to run constantly in one direction and reversing the blades as may be desired. There are various forms of mechanism used for controlling and effecting the reversal, but they fall usually under the two classes, of control by gearing, or by rods and eccentric pins. The hubs of such propellers having to contain a certain part of the reversing mechanism are usually quite large, though not perhaps much larger than those of propellers with separate blades. Such propellers have met with some favor for use on small craft fitted with gas and oil engines, most of which have necessarily to run continuously in one direction. Where a screw propeller is used as an adjunct to sails, it presents a considerable resistance when not in use by being dragged, turning, through the water. In such case a feathering propeller by allowing the blades to be placed fore and aft will present a less resistance than one of the usual form.

Feed Pipe.—A pipe serving to conduct the feed water from the feed pump to the boiler.

Feed Check.—See *Check Valve*.

Feed Heater.—A device for specially heating the feed water before its entry into the boiler. Feed heaters fall into two chief classes according as steam or waste furnace gas is made the agent for effecting the heating. If steam is used it may come from the boiler direct, or the exhaust steam from some of the receivers or from non-condensing auxiliaries such as pumps, blowers, etc., may be employed. Again, the steam used to effect the heating may be either mingled with the feed water direct by some suitable form of spraying device, or it may pass on one side of a series of thin copper or brass tubes while the feed water passes on

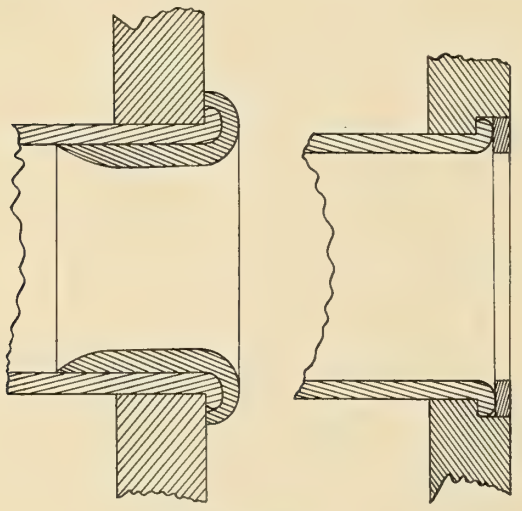
the other, thus effecting the heating by transfer through the metal of the tubes. At the same time the water formed by condensation on the steam side of the heater is collected, trapped out, and turned into the feed-water system, so that no fresh water may be lost.

When the waste furnace gases are used, some form of tubular heater must necessarily be used. The nests or coils of pipe are located in the uptakes or base of the stack, and the water is passed through them or on the inside, while the waste gases pass around them or on the outside. Such forms of feed heaters are coming to be considered as quite an important part of the water-tube boiler. In such case the whole combination may really be considered as a boiler in two stages. The first consists of the feed-water heater in which the water is heated up to nearly or quite the boiling point, but in which it is not desired to actually generate steam. In the second part, or boiler proper, the water thus heated is taken and the operation of conversion into steam is completed. In some cases both forms of feed-water heater are used.

If the original temperature of the feed water is about 100 deg. F., its temperature after passing through the ordinary forms of heaters may be from 150 deg. to 200 deg. With special forms of heater, however, the temperature may be carried quite up to the temperature of boiling.

Felt or Felting.—Some form of fibrous or semi-fibrous fireproof material, made in sheets and used for wrapping steam pipes and boilers, in order to prevent the loss of heat. Fireproof felt is made of a great variety of substances of mineral or of mineral and animal source. A good felt for the engineer's purpose should be fireproof, not too heavy, readily fitted in place about pipes and steam fittings, and should not lose its properties by the long continued application of heat.

Ferrule.—A cast-iron fitting placed in the combustion chamber ends of the tubes in fire-tube boilers. When such boilers are severely forced, especially if the proportion of heating surface is small, the effect is especially severe at the tube ends, where the hot gas enters, resulting in the production of leaks and a



FIGS. 71 and 72.

kind of scoring or wearing away of the metal about the ends. This condition is greatly relieved by the use of cast-iron ferrules, fitted as described above and as illustrated in Figs. 71 and 72.

Fire Brick.—A kind of brick made of clay containing but a small amount of readily fusible substance. It is thus able to stand without injury very great heat and is therefore used for building or lining bridge walls and baffle plates, or other parts of boiler furnaces where metal cannot be used to good advantage.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

The communications of C. J. Enger and of G. V., in regard to matters referred to in this department, are acknowledged. For want of space they are held over for future publication.—EDITOR.

Q.—Having an interest in a small steamer, fitted with compound engines 17 in. and 28 in. by 27 in., Scotch boiler, two furnaces, 32 sq. ft. grate surface, boiler fed direct by pump worked by main engine, no grease filter and feed tank fitted, the information I wish is as follows: Would you restrict all internal lubrication, considering sufficient that entering from valve and piston rod lubrication? If so, granting them in fair condition, how frequently in intervals of time should they be slushed with oil? With an occasional use of the surface blow, say a little every hour, do you think the boiler could be kept free from injury? Would you consider the use of soda the better method? If so, about what quantity and how often would it be necessary to introduce it? Need there be any apprehension of dangerous deposits on fire surfaces from oil? Should I wait until litmus paper test showed water becoming acid, then introduce soda sufficient to neutralize? Would this method be apt to cause boiler to foam? R.

A.—It is impossible to give detailed directions at long range for the oiling of an engine. In general, more oil is used than is necessary, but in restricting the quantity the engineer must be guided wholly by the circumstances of the case. The boiler can doubtless be kept reasonably free from oil by an occasional use of the surface blow as you suggest. You will not forget, however, that this means a waste of heat and that in time you will blow away the cost of an oil filter. With regard to the use of soda, this should not be necessary unless the water is distinctly acid, and such a condition should not result from the presence of pure mineral oil alone. The presence of acid in the boiler means usually either an impure oil or the presence of organic or sewage matter, or a decomposition of the salt in sea water, due to chemical reactions with the other substances present, and the formation of hydrochloric acid. In any case the litmus paper test may be recommended as a guide for the amount of soda and frequency of use. Instead of the use of soda to counteract the acidity of the water, the use of zinc slabs hung in the boiler is rather to be recommended. These are attacked by the acid as formed, which is thus neutralized without special attention other than the renewal of the slabs as may be necessary.

If the surface blow is properly used there need be little fear of dangerous deposits on the surfaces of the boiler within a reasonable time, though of course it is by all means better to keep the oil out of the boiler by reducing the amount used and by fitting a good oil filter. In any event, however, the boiler should be opened and examined at frequent intervals, in order to make sure that everything is in good condition.

Foaming is often due to very obscure causes. The cautious use of soda should not in itself produce this condition. As stated here, however, zinc slabs rather than soda are to be preferred for controlling the acidity of the water, and long experience shows that they may be used freely without danger of causing foaming.

Q.—How are marine engines lined up with main shaft so as to have the plane of revolution of crank at right angles to center line of main shaft, and yet get piston, crosshead, and air, force and circulator pumps in line (when these latter are connected to main crosshead)? Also how is the center line of main shaft obtained in a ship, the stuffing box hole of which is in the ship? Is the line of the engine laid out with a transit or located from the sides of the ship? J. A. P.

A.—Every first-class shipbuilding concern has in its possession an accurate table of figures showing the amount of sag in a fine steel wire of a certain size and stretched to a certain tension, and for certain lengths of the same. In lining up shafting

and locating the centers of bearings in a new job, this wire is stretched. It is fastened at one end and passes over a small pulley at the other end, with a certain amount of weight attached so that the tension is constant. In lining up an engine so that the plane of revolution of the crank is parallel to the center line of the cylinder, as well as the motion of the piston and crosshead, the accuracy attained simply depends upon the care with which the parts are machined in the shops. The gaps in the bed plates that receive the main bearing boxes are planed out so that they are all in line. If the bed plate is in one piece they are all planed in one cut, and if the bed plate is in sections, the flanges of the section are planed perpendicular to the bearings, and are then bolted together so that the gaps are in line, and this can easily be done by trying the sides of the gaps with straightedges. The places where the feet of the columns rest on the bed plate are planed at the same time. If the feet of the columns and also of the cylinders are planed true the cylinder will come in place accurately, and if a wire is stretched through the center of the cylinder and set perpendicular to the gaps in the bed plate at a point representing the center of crank pin box, the bore of the cylinder can be located.

In setting up the attached feed pumps and circulating and bilge pumps many different devices can be used, depending on their kind and location. If they are seated on the main engine bed plate, their seating will probably be planed at the same time that the main bearing gaps were planed, and if the pump bases were faced at the same time that they were bored they will set perpendicular to the bed plate and consequently parallel with the center of cylinder, and the fore and aft position can be located by means of a steel square from the gaps in the bed plate and the steel wire.

The center of the line shaft is located by means of the wire as first described. If the center of the stern tube at the stern post is located, the wire is fastened there and run forward and set central by means of a line run down in the middle, between the frames, to the keel. In twin screw ships the position of the centers at the after bearings is determined by measuring from the center of the stern post out to each, and also squaring off the stern post so that the two centers are at the same level above the keel. On the stocks the latter operation can be done with a level. The two lines are set equidistant from the center of the keel at the forward end. Many other lines and measurements are run to check these, as there may be slight variations in the structure. In most cases the shafts are not longitudinal to the keel, but incline downward on going forward, so that the engine sets low in the vessel and the shafts at the stern are high enough to swing the proper size of propellor above the level of the keel. In large twin screw jobs the shafts incline forward the same as just explained, and also toward the center, so that the engines can be close to each other and allow the propellers to swing without overlapping. Such positions require considerable care to get them accurately located. We know of no work treating of the subject.

Q.—Please publish a rule by which I can find the pressure on a thrust block of engines of a known horse power. Also, is there any chemical by which minerals can be separated from the vegetables in oil? Will the acid separate or saponify the vegetable matter? Also please state what the pay will be of a "warrant machinist" in the Navy under the new law, and where the examinations take place? TEXAS.

A.—To find the pressure on a thrust block the following rule may be employed:

Rule: Multiply the I. H. P. by 22,000 and divide by 101.3 times the speed of the ship in knots. The result is the thrust in pounds.

Thus, if I. H. P. = 1,000 and speed = 10 knots, then:

$$\text{Thrust in pounds} = (22{,}000 \times 1{,}000) \div (101.3 \times 10)$$
$$= 21{,}710 \text{ lb.}$$
$$= 9.69 \text{ tons.}$$

Regarding the oil, if you wish to know a way for separating vegetable oil from mineral oil, the method most suitable for ready use is to boil up the oil with caustic soda or potash—the caustic lye used for cleaning will answer. This will saponify the vegetable oil and leave the mineral oil behind, so that it may be readily separated. Diluted acid will also saponify vegetable oil, but its use is attended with more practical difficulties than that of caustic soda or potash.

Neither of these methods would answer, of course, if it were desired to save the vegetable oil. In such case the resources of a chemical laboratory would have to be called into service.

The pay of a "warrant machinist" will be $100 per month at the start, together with a ration of 30 cents per day, making an equivalent of about $109 per month. With length of service the amount rises from $100 per month at the start to $150 per month after 12 years' service. So far as known, the dates and locations of the examinations have not yet been announced.

Q.—Please explain the method of lining the crank shaft of a small vertical cylinder center-crank marine engine, with 9 in. by 10 in. cylinder. Also the way to tell when the connecting rod is hung fair.

NOVA SCOTIA.

A.—In constructing the type of engine you mention it is usual to plane the bottoms of the gaps in the bed plate that hold the main bearing boxes, so that they are true with the center line of the cylinder. It is consequently a simple matter to adjust the boxes so that they will have the same thicknesses at the bottom, or that the distance from the center of the shaft to the bottom of the gap shall be the same on both sides of the crank. In large jobs the tops of the gaps are also planed true and when the engine is building a gauge is made consisting of a steel straight edge with a tooth in the middle. By removing the top bearing and laying the straight edge across the gap the tooth should just touch the shaft. By means of such a gauge the bearing can be lined up to its original position at any time if it is worn down. If you doubt the accuracy of the boxes of your engine, then you will have to remove the crank shaft, top cover, piston and rods, and stretch a wire through the cylinder, being careful to get it central by measuring from such parts of the cylinder as are not worn, as, for instance, the counterbore at the top or the stuffing box below. See that the wire is taut, and then you can work from this as a center line, using a steel square or straight edge. To find out if the connecting rod is hung fair, disconect the crank pin box or big end, support the crosshead so that the foot of the connecting rod may be swung from side to side, and then caliper the distance between the foot of the rod and the face of the crank cheeks. Turn the crank shaft in different positions and caliper as described, then if the measurements agree for all positions the connecting rod is hung fair.

Q.—Please give me a formula for finding the diameter of boat davits when the weight of boat and the shape of the davits are given. The davits I want to figure on are for a boat 5,000 lb. weight. S.

A.—Where the overhang of the davit is to be several times the diameter, the following formula may be used:

$$d = 2.2\sqrt[3]{\frac{aw}{p}}$$

a = overhang of davit.
w = load for one davit.
p = safe stress per square inch, which may be taken about 7,000 for iron and 10,000 for steel.

According to this formula, one of a pair of davits for a 5,000 lb. boat, a being from 24 to 30 in., would have a diameter of from 4 to 4 3-4 in., according to the material used.

Q.—Please publish a description of different methods of riveting and their relative efficiency. Also the U. S. rule for calculating the pressure on bumped heads of boilers. J. M.

A.—There will soon appear in the educational department of MARINE ENGINEERING full descriptions and rules for the various forms of riveted joints. See also pages 27 to 32 of this issue.

The U. S. rule for bumped heads is as follows:

"*Pressure Allowed on Bumped Heads.*—Multiply the thickness of the plate by one-sixth of the tensile strength and divide by one-half of the radius to which head is bumped, which will give the pressure per square inch of steam allowed."

Q.—Can you give me a value of π beyond the customary five places of decimals? To what extent has it been worked out accurately? LOG.

A.—The value of π (or ratio of diameter to circumference) is given to thirty-two places by Molesworth as:

$\pi = 3.14159265358979323846264338327950 +$

If we are not mistaken an English mathematician worked this out to 600-odd places about thirty years ago, and the story is that one of the most eminent mathematicians of that time started in to check the figures, but after finding no inaccuracy as far as 400 places he got discouraged and quit.

Vol. VI of the Transactions of the Society of Naval Architects and Marine Engineers has been issued from the office of the Society, 12 West Thirty-first street, New York. This contains the full text of the papers read before the 1898 meeting of the Society, held last November, together with a complete report of the discussions which took place at the meeting, and those which were in the shape of written communications. There is an especial interest in this volume in that it gives an account of the meeting held during the war year, and which consequently was the occasion for much statement of fact and comment in connection with the operations of our Navy. Aside from the value of the text, the volume would be indispensable for the sake of the plates, containing working drawings and valuable photographs which occupy fully one-half of the volume. Those contributed by Chief Constructor Philip Hichborn, U. S. N., covering a great range of vessels from a practice sailing ship through a great variety of competitive designs for torpedo boats and destroyers to first-class battleships, are of the greatest practical and scientific value, a splendid contribution to the literature on these subjects. Another invaluable series of drawings is that which accompanies the paper on small boats, by Arthur B. Cassidy, U. S. N. The fine professional spirit which gives out these experiences for the benefit of all engaged in such work is a feature which fitly indicates the aims of the Society. This volume is of the very highest interest and value and is indispensable to the practising naval architect and engineer. It is sold at the low subscription price of $10.00.

TRADE PUBLICATIONS.

The Boston Belting Co., 256 Devonshire street, Boston, Mass., is sending out to all its friends a private postal card ilustrating the fact that antiquated outfits in rubber goods must go. The picture represents a small child driving a hobo before him with a stream of water from hose.

The 1899 catalogue of the Marine Iron Works, Station A, Chicago, Ill., is just received. It is very fully ilustrated, containing pictures of the different types of simple engines manufactured by this company, the illustrations being full page in size, so as to give much detail. Equal information is given regarding compounds, both steeple and fore and aft, together with a great deal of other information regarding special features of steamboats and vessels. A fine picture is shown of a triple cylinder and also of a stern paddle wheel engine of modern type. There is also much information regarding different types of boilers, both vertical, horizontal, Scotch, etc., which this company makes, and a full line of propeller wheels and all other kinds of steamboat machinery. Any of our readers interested in steamers of any kind, from a small launch to large river boats or fine steam yachts, will want a copy of this catalogue for permanent reference.

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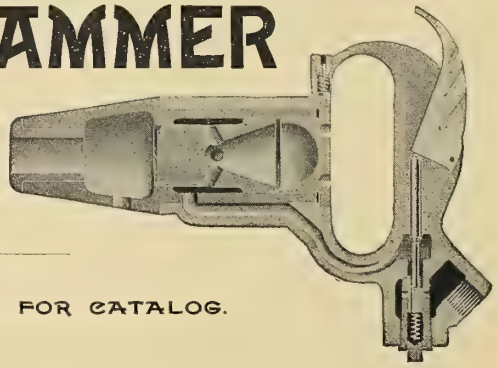

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EXTRA HEAVY FOR HIGH PRESSURE MARINE BOILERS.
SPECIAL AIR CHIME WHISTLES FOR NAPHTHA LAUNCHES.

KINSLEY MFG. CO.,
Sole Manufacturers,
Bridgeport, - Conn.

"Learn to Draw" and "Can You Read a Drawing?" are the titles to two folders issued by the International Correspondence Schools, Box 1111, Scranton, Pa. The subject of drawing is one which will interest our readers, and many will undoubtedly want to send for copies of these pamphlets.

A catalogue regarding the projector search lights manufactured by Thomas P. Benton & Son, La Crosse, Wis., is now ready for distribution. The catalogue contains a detailed description of the lights, giving the manner of their construction and the various kinds, showing their adaptability to vessels of any type, from a small river boat to a large steamer.

Sturtevant electric fans are illustrated fully in a four page folder, Bulletin M, issued for the month of April. The illustrations are of large size and are exceptionally fine, bringing out all the details of the motors used. These electric fans are made from one-sixth horse power up to twenty horse power and are particularly adapted to steamship work.

Seamless cold drawn steel boiler tubes as manufactured by the Shelby Tube Co. are fully described in an eighteen page catalogue. Considering the steady increase of high pressures and the importance of seamless tubing, all of our readers will want a copy of this catalogue, which is not an ordinary trade affair, but written in such a way as to give much valuable information. Considerable attention is given to the manner in which tubes are manufactured, and much other interesting and valuable information is given. Seamless tubing, as the catalogue states, has met the approval of and is preferred to all others by the British Admiralty, while the United States Navy has nearly all of the torpedo-boat boilers fitted with seamless cold drawn steel tubing, and the specifications have been revised so as to admit of its use in boilers of the Scotch type. A considerable extract is given on page 12 of the catalogue of the specifications and inspection of such tubing for use in the Navy. Copies can be had by applying to the Shelby Tube Co., Cleveland, Ohio.

BUSINESS NOTES.

GARLOCK PACKING.—The Garlock Packing Co. calls attention to the packing of its manufacture, which it claims to be of only one grade and that the best. This company makes packing for any use where soft packing can be applied, and makes a specialty of supplying packing for special uses. The head office of the company is in Palmyra, N. Y., with sales offices in all the leading cities.

BRASS AND COPPER GOODS.—The U. T. Hungerford Brass & Copper Co., 121 Worth street, New York, has recently added a large warehouse and shipping department, and is now in shape to fill orders promptly for seamless brass and copper tubing, brazed tubing, sheet and bolt copper, rivets, tacks and nails, and a full line of other articles made of either of these metals.

WALWORTH MFG. CO., 14-24 OLIVER STREET, BOSTON.

Specialty of **BRASS VALVES** and Fittings for MARINE CONSTRUCTION

Extra Heavy Valves, Vent Pipe and Fittings for High Pressure Work.

SOLE MANUFACTURERS OF

VAN STONE PIPE JOINT

Which does not Weep under heavy pressure.

SEND FOR CATALOGUE. Prices and Terms on Application.

THE JOSEPH DIXON CO.—The annual meeting of the stockholders of the Joseph Dixon Crucible Co., Jersey City, N. J., was held last month and all the officers were re-elected. The report to the stockholders shows one of the most satisfactory years of business in the history of the company, particularly in the demand for graphite paint for protection against the elements.

TIN PLATE.—In the many uses for which tin plate is necessary the matter of quality plays an important part, especially where there is much exposure to the elements. Special attention is given to this subject by Merchant & Co., 517 Arch street, Philadelphia, Pa., who claim to carry only those plates which are heavily coated and which are of a quality to withstand the greatest amount of exposure. This company has made a specialty of these plates for a great many years and has recently filled an order for several carloads for shipment to the southern states.

DRAUGHTSMEN'S SUPPLIES.—Our readers will be interested in the advertisement of the Keuffel & Esser Co., 127 Fulton street, New York, which furnishes everything required for drawing and measuring. This company is one of the recognized leaders in the country in this line of business and the standard of quality of its goods is well known. Practically everything sold by this company is either manufactured in its own shops or absolutely controlled by them, and quality is guaranteed. A very complete and thoroughly illustrated catalogue of over 400 pages is sent free of charge to all inquirers who hold positions in which drawing or measuring instruments are used.

FIRE PROTECTION.—A new form of fire extinguisher has been perfected by the Deming Co., of Salem, Ohio, for use in offices, shops, warehouses, and on yachts or steamboats. It consists of a readily portable bucket with pump, hose and nozzle attached. The nozzle is arranged so that it will give a spray or solid stream, and in the former case it is useful for cleaning windows and woodwork of all sorts. When the bucket is filled the pump is ready for instant use, and an advantage is that its condition can be seen at a glance and the apparatus thus kept constantly filled and ready for any emergency.

PNEUMATIC TOOL INTERESTS CONSOLIDATED.—One of the most important and interesting events in pneumatic tool matters of late was the purchase on April 6, by the National Pneumatic Tool Company, of Philadelphia, Pa., from the American Pneumatic Tool Company, of New York, of the sole and exclusive right to manufacture pneumatic chipping, caulking and riveting hammers under all patents owned by the latter company, which was the first concern to place this class of tool on the market. The American Pneumatic Tool Company has brought a number of suits for infringement of its patents on both valve and valveless hammers, and the United States Court of Appeals for New York has decided in its favor. It is said to be the intention of the company to bring additional suits for infringement against users of hammers not manufactured by the National Pneumatic Tool Company.

TWO PAINTS IN MARINE PAINTING.

The kind of paint used on a ship's hull and its effect upon marine growths are important considerations, bearing upon the ship's speed and thus, directly, upon its earning capacity.

That paint which presents the smoothest surface, least retards the motion of the ship through the water and affords the poorest lodgment for marine growths.

Of all the oil paints there is but one which retains its gloss and its smooth surface in the presence of salt water, and that is **Zinc White.** Red Lead (the old favorite), has but little gloss when first applied and quickly decays, but if the red lead be combined with a fair proportion of **Zinc White,** the coating obtained is smooth and glossy and remains so. Any other marine paint is similarly improved by the addition of **Zinc White.**

For ships' interiors, it is generally recognized that no other pigment will hold its color. **Zinc White** is an essential constituent of all marine paints, whether for interior or exterior use.

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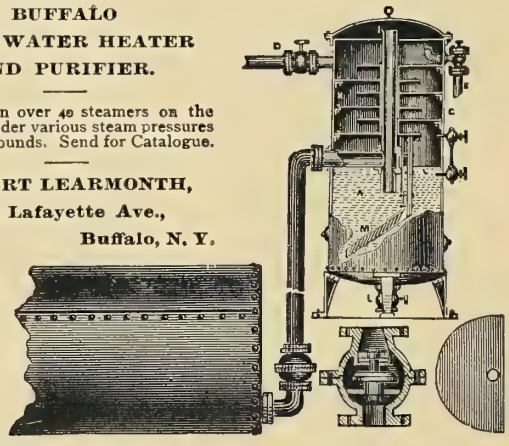

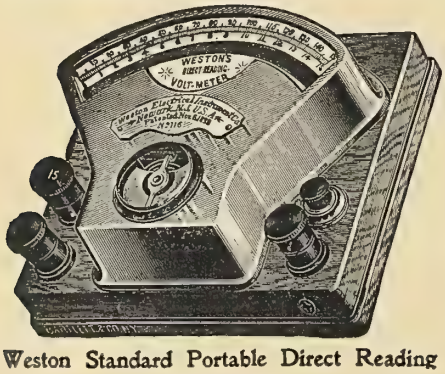

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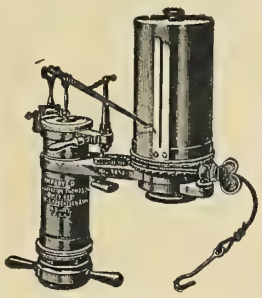

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BALDT ANCHORS.—We are informed by the Baldt Anchor Co., Chester, Pa., that with the large facilities at hand for manufacturing it now carries a large number of anchors in stock and can fill orders without any delay.

DECISION REGARDING MAGNETIC BLOW-OUT. — The Thomson-Houston Electric Co. endeavored to enjoin the Bullock Electric Co. from using a magnetic blow-out with controllers, claiming that the Bullock company infringed Letters Patent Nos. 283,167 and 401,085; but Judge E. H. Lacombe, on March 6, after hearing the arguments in the case, refused to grant this injunction.

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FIREPROOF WOOD.—The American Wood Fireproofing Co., 11 Broadway, New York, is building large works at Newark, N. J., and will soon be in position to fill all kinds of orders for fireproofing timber and lumber for all purposes used in marine work. This company will either do the fireproofing itself or sell the rights for others to do it under royalty.

HOWDEN HOT DRAFT.—The two freight steamers which the Detroit Dry Dock Co. is about to build will be duplicates, 440 ft. over all. Each vessel will have two Scotch boilers. These two steamers, as well as the package freighter building at the yard of the Union Dry Dock Co., Buffalo, for the Western Transit Co., will be fitted with the Howden system of hot draft.

BROWN HOISTS.—The Brown Hoisting and Conveying Machine Co., Cleveland, O., has been awarded a contract from the Navy Department for coal-handling machinery for the coaling station at Mare Island Navy Yard, California, which is the sixth coaling station for the United States Navy to be equipped with machinery of this company's manufacture, and constitutes all the stations so far awarded. The company has also secured the contract for a 100-ton steel floating crane, weighing over 1,000 tons, for the New York Navy Yard.

INCREASED FACILITIES FOR MACHINE BUILDING.—Owing to the great demand for tools for shipyards, boiler shops, etc., the Hilles & Jones Co., Wilmington, Del., has begun work on a new steel frame addition to its plant, 80 by 150 ft. This shop will be fitted up in the most modern style.

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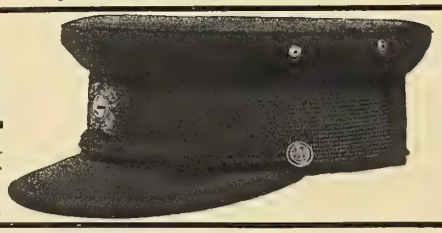

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

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Two new Scotch Boilers 12 ft. 6″ diameter, 12 ft. long, with 3-40″ corrugated furnaces, built under Marine Inspection Laws for 130 lbs. pressure. Specifications and blue prints furnished on application.
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Five-horse Water Tube Boiler, my patent, for sale. Suitable for inland waters only, all steel plate and tubes, no bricks or castings. 175 pound steam pressure carried. Weight only 450 lbs. for 35 sq. ft. h-s. Will drive 4″ x 4″ simple engine 450 revs. per minute. Stands in 30 inches square. Entirely new.
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